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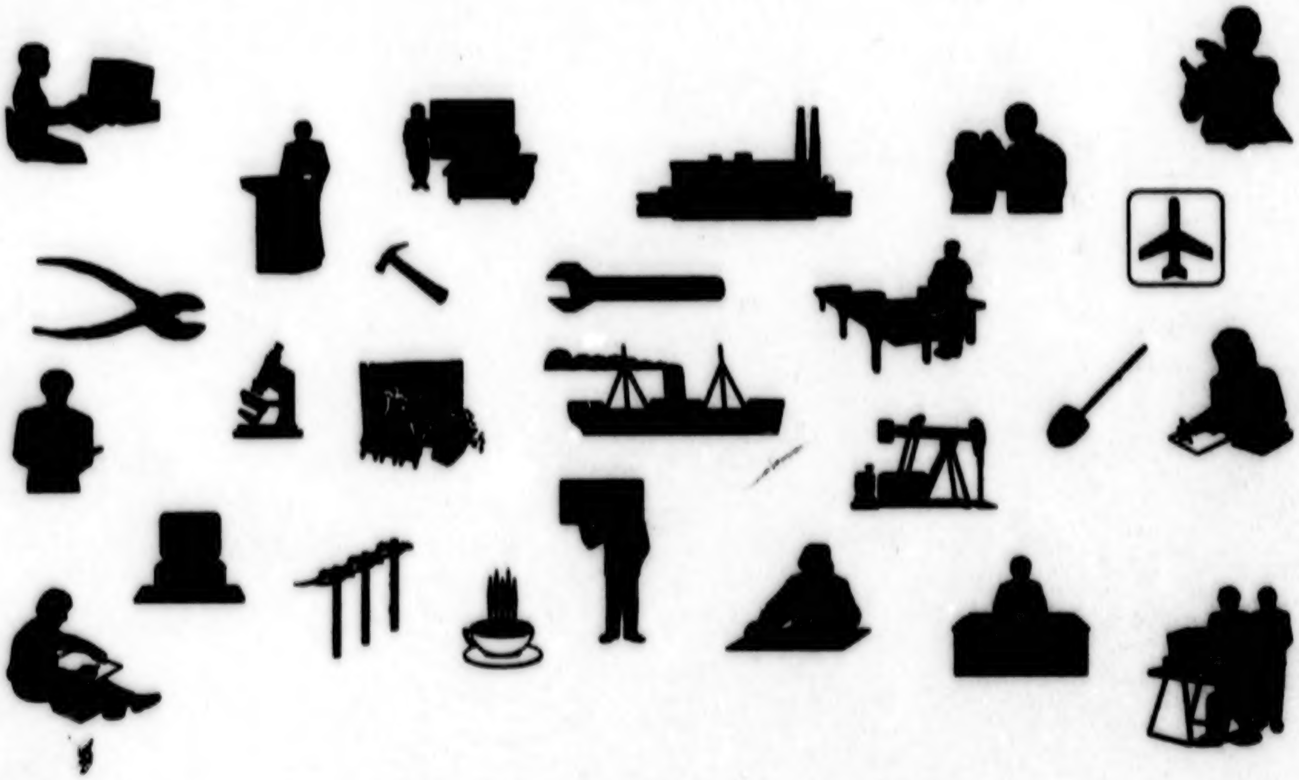
Standard Occupational Classification Revision Policy Committee



Seminar on Research Findings

April 11, 1995

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PREFACE

This publication contains the papers presented at the April 11 Seminar on the Standard Occupational Classification (SOC) revision. The Office of Management and Budget appointed a Standard Occupational Classification Revision Policy Committee (SOCRPC) to develop policy for the revision of the SOC system. The SOCRPC is chaired by the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor, with representatives from the Employment and Training Administration of the U.S. Department of Labor, the Bureau of the Census of the U.S. Department of Commerce, the Office of Personnel Management, the Defense Manpower Data Center of the U.S. Department of Defense, and *ex officio*, the Office of Management and Budget, the National Science Foundation, and the National Occupational Information Coordinating Committee.

In order to be informed regarding issues relevant to the various conceptual options for the new SOC, the SOCRPC commissioned six papers. The authors and the topics of their papers are as follows:

1. Peter Cappelli -
   "Conceptual Issues in Developing a System for Classifying Occupations"

2. Peter Cappelli -
   "Systems for Classifying Occupations Based on Supply and on Demand"

3. J.W. Cunningham, D.W. Drewes, and T.E. Powell -
   "Framework for a Revised Standard Occupational Classification (SOC)"

4. Daniel Flaming and Odessa Dubinsky -
   "Mapping Workforce Skills"

5. Ronald D. McCage and Chris Olson -
   "Observations Regarding a Revised Standard Occupational Classification System Using a Skills-Based Concept"

6. Joseph Waksberg, David Cantor, Kerry Levin, et al. -
   "Issues/Problems in Data Collection and Measurement of Occupational Information from Household and Establishment Surveys"

SUMMARY

The following is a brief description of some of the major points in each paper.

The papers by Cappelli; Cunningham, Drewes, and Powell; and McCage and Olson, deal primarily with the conceptual foundation of the SOC. Cappelli begins by discussing the basic aspects of successful classification systems. He then relates these to specific conflicts to be overcome in developing the new SOC. He discusses the tension between similarity of tasks performed or skills required and relationships between the production process or internal labor markets. This is labeled "similarity" vs. "causation". Cappelli also discusses other areas of concern: how to classify future jobs that don't yet exist; the tradeoff between parsimony and completeness; and the criteria for determining "similarity" of cases. He senses that users of the SOC will be interested in skills and that employers want information on labor market trends. He recognizes, however, that more data are needed from individuals about their jobs, that constraints exist on the number of questions surveys can ask, and that it is becoming increasingly difficult to assess tasks due to changes in the workplace. He calls for a flexible SOC, in line with the Dictionary of Occupational Titles (DOT) database being developed by the Employment and Training Administration. Cappelli believes that different occupational classification systems can be generated from the same set of descriptive information. The Canadian and Australian occupational classification systems are mentioned as examples of incorporating skill and relating jobs to skill type and skill level. His analysis of demand and supply models, between tasks and attributes, concludes that task and trait based systems may not be very different and that a combination system based on task, trait, and context criteria is desirable.

Cunningham, Drewes, and Powell suggest that the new SOC be based upon work activity statements, which are, by nature, demand oriented. They see all work as being describable by generalized work activities, which can capture human capability requirements. They envision the SOC being structured according to skill level and skill content. The classification would be created by numerical profile matching and be established in a hierarchical structure with divisions, major groups, minor groups and occupational units which would link with the reinvented DOT and would serve users in the field.

McCage and Olson write about a new SOC using a skills-based concept which builds upon what already exists, specifically the DOT Content Model, the Classification of Instructional Programs category families, the Occupational Employment Statistics (OES) survey, and the BLS Prototype Skills-Based Job Family Matrix. Their model would include 12-14 occupational families with 600-700 job clusters and be divided among five skill levels.

The paper by Flaming and Dubinsky concentrates on user needs. They discuss the roles of direct and indirect users, and suggest that the new SOC should target the needs of indirect users, i.e., people looking for jobs. They state that the most important need is that of current labor market information which unemployed workers can use to find jobs. For them the new SOC must provide a foundation from which labor market information can be produced. The results from a survey of potential users point to a SOC which is based upon worker skills and includes skill measurements along with tasks performed and an identification of industries. The need for up-to-date, accurate information which can support occupational projections is mentioned. The paper identifies users' desire for a common language for classifying skills and identifying jobs for which those skills are required. This would be helpful for those seeking employment.

Waksberg, Cantor, and Levin concentrate on measurement issues, specifically the methodological and sampling issues that are involved in collecting data using a skills-based SOC. They examine the major employment data collection surveys: the BLS OES (establishment-based), and the household-based Current Population Survey, and the Decennial Census of Population and Housing. They discuss the strengths and weaknesses of each and relates the sample sizes to the ability to produce accurate estimates of employment for various numbers of occupations. The paper suggests that it may be necessary to merge the systems into a SOC with somewhat less detail than now exists and that if the new SOC involves significant change from what is currently used, a dual sample will be needed to measure the actual change in the resulting data.

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Conceptual Issues in Developing a System for Classifying Occupations

by

Peter Cappelli[1]

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[1] Co-director, National Center on the Educational Quality of the Workforce (EQW) at the University of Pennsylvania. This manuscript was prepared for the Standard Occupational Classification Revision Policy Committee under contract to DTI. The views contained are solely those of the author and do not necessarily reflect those of the Committee.

Executive Summary

Abstract

The charge for this paper is to consider the broad set of issues that might be considered in revising the Standard Occupational Classification (S.O.C.) system with the goal of helping advance specific recommendations about changes in the current system. The place to begin considering revisions is with a framework that outlines the conceptual issues that all systems of classification face. The arguments presented below use such a framework to draw conclusions about the present version of the S.O.C. and to suggest possible changes in future versions. Perhaps the most important suggestion is to consider more flexible arrangements, building on the options inherent in the new Database on Occupational Titles (D.O.T.) that would allow users to customize the way occupational information was classified and presented to them.

Learning from Other Systems

The main contribution of this paper is to consider what might be learned from classification systems in other fields, especially the natural sciences. The common interest that drives the need to classify material in all fields is to provide an efficient and parsimonious guide to individual cases that reveals information about those cases.

The problems with classification systems begin with a series of ontological issues in that any classification creates groupings that are in some important sense artificial. It is important, therefore, to find some grounds on which to justify these systems and criteria for preferring one system over another.

The first issue a classification system needs to address is to set up general criteria to guide its groupings. Virtually all of the debates about such criteria come down to a tension between two principles. The first one is that better classification systems are those where a greater number of general and more important propositions can be made about the individual cases than for other systems. The tension in this principle is that very complex systems allow many more propositions to be made, but each individual proposition about the individuals in a grouping becomes less important -- at the extreme, trivial.

The second principle is that the classification system should reflect the causal influences that placed individuals' cases in these different groups or some underlying theory about how the individual cases relate to each other. Saying that the groupings are based on similarities is in line with the first principle but says nothing to the second.

In biology, for example, the tension is between classification systems that group cases according to their similarities and those that group cases based on the evolutionary development. With respect to occupations, the equivalent tension is between systems that group jobs according to the similarity of tasks performed or skills required and those that reflect relationships to the production process or the hierarchies of internal labor markets.

Various decision rules are considered for evaluating what constitutes "good" classification systems such as robustness (do they produce what they claim to) and especially usefulness. These discussions lead to the following general questions for any effort to revise the Standard Occupational Classification system:

- What basic decision rule should govern groupings and hierarchies, similarity or causation?
- How important is the ability to classify future jobs that do not yet exist?
- What trade-offs between parsimony and completeness should we accept?
- What criteria should be used to judge how "similar" individual cases in groupings should be?

The arguments then turn to a consideration of the purposes that the Standard Occupational Classification (SOC) system should serve in an effort to develop criteria for answering these questions and evaluating alternative systems.

Implications for the S.O.C.

Information from users and potential users of the S.O.C. suggests a range of interests that are not always compatible. One set of interests might be described as benchmarking, learning about other jobs with similar skills or about what similar jobs pay elsewhere, comparing jobs with those in other countries, etc. These interests can be met with a classification system where the groupings are based on similarities almost irrespective of how the hierarchy is organized. But consider another set of interests that turn on information across occupations. Learning about career advancement opportunities, for example, requires that occupations be organized in ways that reflect promotion ladders in the workplace, that they reflect the causation of internal labor markets.

The second issue on the list relates to the ability to accommodate new jobs as they are generated in the future. The simple method of creating clusters and classifications based on similarities among existing jobs -- based on the dominant characteristics of existing jobs -- may lead to a system that cannot easily accommodate new jobs.

The third and most important area also concerns issues associated with similarity and the trade-off with parsimony. Information from current users suggests that parsimony and having a simpler system, at least at present, may not be that important a concern. Further, the interests of the various users are different enough that they may require substantially different information -- different classification criteria. And any simple system will make it impossible to accommodate those demands.

Considering the 12 criteria used for grouping occupations in the current S.O.C., it is not until the fourth criteria that one hears explicitly about putting similar occupations together. The first principle suggests the notion of causation discussed earlier, that the S.O.C. reveals the underlying occupational hierarchy in the workplace -- the logic of internal labor markets -- generally within individual organizations. The principles of placing apprentices and trainees in with the occupations for which they are being trained even more clearly reflects the principle of causation. This arrangement may conflict substantially with the notion of similarity in groupings; apprentices in metalworking, for example, may in fact be more similar to and perform tasks that are more like apprentices in woodworking than they are like fully-skilled metal working craftsmen. The fact that "helpers" are explicitly grouped separately from apprentices and from the craftsmen that they assist is perhaps the most explicit example of the causality classification principle. Helpers are grouped separately because, unlike apprentices, they will not advance to craftsmen jobs.

The ninth principle governing the S.O.C. suggests creating separate groupings for supervisors and supervisees, clearly suggesting that the characteristic of "supervision" override other characteristics of similarity between occupations. As MacDonald and Hadlock (1993) note, the second principle of using work or tasks performed as the grouping criterion may well conflict with the third principle which is to use industry/place of work as a criterion.

Critique of the S.O.C.

A review of the S.O.C.'s current classification criteria suggests that the decision rules are reasonably rich or complicated, depending on one's perspective. A fair amount of questions are required to classify a job. The answers provide rather limited information on each aspect being examined because they ask "yes/no" questions about categorical variables such as whether the job is supervisor or supervisee, apprentice or fully qualified employee. The criteria do not reveal much about the depth or range of a given variable or the variance (as opposed to the range) or tasks performed. In this sense, the S.O.C. is more like a classification system based on causation than one based on similarity.

The classifying criteria represent a compromise between the similarity and causality principles. Similarity reflects tasks performed rather than characteristics of employees. The principle of causation appears to be more dominant in its interest in reflecting the internal organization of work inside establishments and, in turn, the current structure of occupations in the U.S.

A brief review of what S.O.C. users say they want in terms of information suggests that the main organizing principles behind the S.O.C. classification system do not reflect the issues that users seem to care about. While the S.O.C.'s main goal is to reflect the occupational structure in the workplace, relying largely on internal labor markets and career progressions (and to a lesser extent tasks performed) to generate that structure, users seem most interested in skills required for occupations. Skills are not an explicit part of the S.O.C.'s organizing principles, which suggests a problem even for those who currently use the S.O.C.

Employers in particular would seem to be interested in classifications that reveal information about skills because such a system would help them learn about labor market trends. The reason for paying particular attention to the interests of employers is because there are strong arguments for believing that if they adopt and embrace a particular system, other interested parties will as well.

Are Work and Skill Demands Changing?

The organization of work in the U.S. appears to be undergoing considerable change that in particular pushes more decision making power onto the front-line workers. An overall summary of how work may be changing includes the following conclusions:

- Work practices are changing with more establishments using teams, employee participation, and other such arrangements. But these arrangements are by no means in all industries and occupations and are not yet close to being in a majority. While the prospects for increased diffusion look good, there are also important reasons for believing that there will be limits to the spread of these practices.

- Where new work practices have been introduced, skills appear to be higher, although how much higher is hard to gauge, and the skill demands that have increased seem to focus on behavioral skills.

- With respect to the nature of these new skills, new production techniques like lean production change jobs by broadening them, eliminating certain narrow jobs, and loading their tasks onto others. Teams, employee participation, and the other more popular new work practices often lead workers to move across a much wider variety of tasks that often includes supervisory tasks.

Many of the above changes make it increasingly difficult to use tasks performed to define or differentiate occupations. First, the set of tasks that a given worker performs is now much broader and more likely to overlap with what workers do. Second, to the extent that workers do have a core set of unique tasks, those tasks may now take up a much smaller proportion of their working time.

In summary, while new work practices may make new demands on worker skills, the demands may not be overwhelming, and they may focus more on behavioral skills than on traditional vocational skills. The fact that tasks are changing in ways that make it increasingly difficult to use them for the purposes of classifying occupations suggests the need to rely more on other criteria in developing classification systems. And the fact that the changes seem to focus attention on new skills suggests that classification systems should make those skills more of a focus of their attention.

Skills-Based Systems

The full paper considers a range of problems in developing measures of skills that could be used as part of an occupational classification system. While recognizing that no skill-based system at present is likely to meet academic standards on issues like validity and reliability, the distinctions used in the D.O.T. between basic, cross-functional, and occupation-specific skills seem to be the most appealing criteria to use as a way of including skills into a classification scheme. They strike a reasonable trade-off between parsimony and richness and get at the labor market information that may become increasingly important.

Perhaps the trickiest issues to address are those associated with implementing a change in the S.O.C. New and more detailed information needs to be collected from individuals about their jobs in order to develop any new classification system, and there are clearly constraints on how many such new questions the surveys conducted by the Census and the Bureau of Labor Statistics can ask.

A Proposal

Most of the more difficult issues associated with designing classification systems occur because of trade-offs associated with having to pick a single system. Compromises between criteria and interests may prove especially unsatisfying.

The breakthroughs in occupational classification systems in the past, I believe, have been to expand the information available to users by changing the form of the presentation. The National Occupational Classification of Canada, for example, is notable in part because it incorporates some aspect of skill into the classification system but also because of its matrix presentation that relates jobs to skill type (type of work performed) and skill level at the same time.

Perhaps the most important development in recent memory in the U.S. with respect to job-related information has been the revision of the Dictionary of Occupational Titles into a database form which broke classification efforts out of the box of two dimensional information reporting imposed by a sheet of paper. Different users can access a wide variety of information from the new Database of Occupational Titles in very different ways.

Any occupational classification system must be compatible with and ideally should be based on the criteria and information used in the D.O.T. What would be ideal, I believe, is for the revised S.O.C. to offer at least some of the flexibility that the new D.O.T. presents.

A revised S.O.C. begins with the descriptive information about jobs collected through surveys conducted by the Census and the B.L.S. Classifications are only as good as the information on which they are based. As noted in the implementation discussion above, the range of information that describes a respondent's job has got to be expanded if the classification system is to convey more information. Including skills along the dimensions noted earlier seems an important addition.

Just as the new D.O.T. allows users to cut its information in different ways, the sophistication of modern databases makes it possible to generate several different occupational classification systems from the same set of descriptive information about jobs. There seems to be a clear demand for a classification based on skills similarity that would make it easier to learn about labor market issues. There is also a clear and continuing demand for an industry-based classification that would map onto existing industry data. These two classifications are not obviously compatible. A matrix not unlike the Canadian version could make it possible to see how a given job fits into both a classification of skills and a classification of industry. Having two separate systems requires no new data and makes no more demands on implementation than would a single, compromise system.

Purpose and Background

The charge for this paper is to consider the broad set of issues that might be considered in revising the Standard Occupational Classification (S.O.C.) system with the goal of helping advance specific recommendations about changes in the current system. The place to begin considering revisions is with a framework that outlines the conceptual issues that all systems of classification face. The arguments presented below use such a framework to draw conclusions about the present version of the S.O.C. and to suggest possible changes in future versions.

Classifications--Learning from other Fields

The idea that occupations should be grouped together in some hierarchy reflects an interest that is common to virtually every area of inquiry. Natural sciences like chemistry with its periodic table of elements or even fields like literature where writing is organized by form (the novel, the short story, etc.) reflect this common interest in classifying subject matter.

What is the common interest that drives the need to classify material? The most important interest is to provide an efficient and parsimonious guide to individual cases. Consider the situation in the absence of a classification system. We could, for example, describe a work of literature with an elaborate list of characteristics about it that would uniquely identify that work and distinguish it from any other. Such an undertaking would be quite time consuming, however, and in some cases it might almost be simpler just to have the listener read the book to find out about it. Attempts at a simpler description in the absence of a classification system might typically involve comparisons with other cases ("this book is a lot like 'Humbolt's Gift,'" e.g.) which demand that the listener already have a deep knowledge of the field in order to understand many descriptions.

The use of even a simple classification system, on the other hand, can convey a great deal of information about a case very quickly; saying that a book is an historical novel from the Elizabethan period tells a lot and makes fewer demands on our literary background. The main interest in a classification system, therefore, is to convey as much information as possible about the individual cases within a class. Just what information should be conveyed, what trade-offs should be made between parsimony and information content, and how one evaluates alternative classification systems are among the central questions that cut across all classification efforts.

As noted above, most fields find themselves engaged in classifying cases, concepts, and material within their domains, and the issues involved in these efforts are frequently common across the fields. Virtually all of the discussion of classification issues, however, takes place within the context of individual fields. The discipline with arguably the deepest interest in classifications is biology -- in particular its subfields of zoology and botany which are basically devoted to classifying animals and plants, respectively. Much of the discussion below draws from research in those fields.

Some Definitions

The study of the diversity of cases and the relationships between them, a study that naturally leads to groupings, is referred to as "systematics." The study of how cases are grouped and organized into hierarchies is defined as "classification"; and the study of classification in the abstract, particularly the philosophical issues involved, is known as "taxonomy."

Basic Issues of Taxonomy

One of the first issues faced by any system of classification is the ontological status of that system. Any grouping that we create is in some essential way arbitrary and artificial. The individual cases under consideration exist independently of the efforts of the observer. But that is not the case for a group or classification where the observer has essentially created that particular structure, imposed that organization and boundary around a particular set of individual cases.[2] Even where the boundary is apparently a natural one, creating a group such as the nations of the Mediterranean, the question remains as to those particular criteria were chosen over other natural ones.

Where the classification is based on a single element or characteristic (monophyletic), it seems objective -- e.g., the grouping by sex into males and females. But further consideration reveals the artificiality of even this grouping; human males and male fish have extraordinarily little in common, for example, and why the division should be based on sex and not on other characteristics is not immediately obvious. When classifications are based on more than a single element (polyphyletic), the groupings seem even more artificial -- why these two elements and not three, e.g.? (See Cracraft 1983.) Yet systematists have long recognized that no single element will ever provide a coherent system of classification as it has always been possible to think up exceptions that either do not fit into the categories or that do not have that property. With respect to the division based on sex above, for example, hermaphroditic organisms like certain worms do not fit in the system, and defining what counts as "male" or "female" is not always straight forward across all organisms.

These questions suggest that the first issue a classification system needs to address is to set up general criteria to guide its groupings. Philosophers at least since John Stuart Mill have wrestled with this issue. Two principles stand out. First, better classification systems are those where a greater number of general and more important propositions can be made than for other systems. The tension within this principle is between very complex systems, where many more propositions can be made but each individual proposition about the individuals in a grouping may be less important -- at the extreme, trivial -- and simpler systems, where the fewer propositions that can be made are more important.

The second principle is that the classification system should reflect the causal influences that placed individuals' cases in these different groups (see Gilmour [1940]). Another way to say this is that the groupings should reflect some common theory about how the individual cases relate to each other. Saying that the groupings are based on similarities is in line with the first principle but says nothing to the second.

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[2] See Gilmore 1940 for a general discussion of these issues.

These two principles reflect a fundamental division in biology and, I suggest, in other fields as well. Phenetic systematists ("pheneticists") assert that classification systems in zoology and botany should be based on the overall similarity of individual cases or "taxa" being grouped together. Their position asserts the primacy of the first principle above. Exactly what criteria should be used to establish similarity and how that similarity should be measured are complicated questions considered below. Phylogenetic systematists or "cladists" (from the word cladist which refers to ancestral pathways), in contrast, assert that classifications should be based on the principle of evolution; each individual case should be placed in a group that reveals its history. The hierarchy of groupings, in turn, suggests the path of evolution, the causal influence that led to the characteristics of each individual in a given group. Their position is consistent with the second principle above.

We see strong parallels in classification systems in many fields including the classification of occupations. The classification systems being considered by the National Skills Standards Board, for example, are to be based on the first principle --occupations are grouped together based on similarity with respect to a criterion like skill requirements. The Standard Occupational Classification (S.O.C.), in contrast, creates a hierarchy of groupings that reflects, in large part, the technical requirements of employers (see below). The S.O.C. reveals the causation driven by the logic of internal labor markets and production systems.

Because of the parallels between the issues facing occupational classification systems and those in biology, it is illuminating to review what has been learned about these issues in biology. Impatient readers should be warned, however, that in general, reviews like these are better at raising questions than answering them.

The Problems of Similarity

As noted earlier, the main point about classification systems is to tell us something about the individual cases within each group, that these cases share important similarities that are illuminated by the groupings. In biology, even phylogenetic systematists who argue that evolutionary pathways should be the basis of classification believe that the groupings that result from such systems should put together individual taxa that are similar in important ways. For phenetists, similarity is the guiding principle of classification, not just a desirable outcome. So perhaps the place to begin is by considering the issues raised when the goal is the first criterion of classification noted above, making general statements about individual cases based on groups that place similar cases together.

Systematists are always guided, sometimes implicitly, by assumptions about the natural world, how characteristics or elements are distributed across individual cases. Antoine-Laurent de Jussieu and his followers began what many consider the modern systems for classifying plants with a "natural method" that emphasized rules based on multiple elements (see Stevens 1994). Implicit in their method is the idea of plenitude, that the range of diversity in the universe is continuous.

This assumption brings with it an important corollary, "the principle of continuity." If in theory one can imagine missing cases -- gaps between existing cases where one might expect to see other examples -- then one can assume with this corollary that the missing cases exist somewhere in the past or present. In terms of creating classifications, this corollary suggests that it is not sufficient to establish classifications around observed cases. Instead, groupings can be created synthetically, guided by theory, to create a complete mapping of the imaginable classifications (see Lovejoy 1936).

In considering occupational classifications, one might see a similar issue of plenitude. Tasks change constantly, as do the groupings of tasks which together create jobs, and these changes occur far more rapidly than do the evolution of new taxa in the natural world. What kind of assumptions should one make about unobserved occupations? One might assume that we cannot predict what new occupations will look like with any accuracy. It would be reasonable, therefore, to assume that the probability of a new occupation occurring in any "space" of a mental map of conceivable jobs is about equal; in the long run, the entire continuum might be filled. And efforts to develop a classification system that can accommodate in advance these future jobs might embrace the synthetic approach of the early systematists in biology and map out conceivable occupations under the assumption that they will eventually be "discovered."

Another basic issue in systematics is whether one builds a classification system by working up, classifying groups into increasingly larger groups, or working down, subdividing groups into smaller categories. These techniques are referred to as synthesis (looking for similarities) and analytic techniques (looking for differences), respectively. Those who accepted the assumption of plenitude and infinite variation saw the idea of working down as artificial. They believed not only in infinite variety -- which implied that organizing by differences would be a potentially endless exercise -- but also that taxa could be organized from the simple to the complex. Working up toward increasingly larger groups revealed that simple organizing logic; working down could lead to artificial and unnecessary distinctions.

Similarity Criteria

As noted earlier, it is generally recognized that a good phenetic classification system will rely on many elements or characteristics in determining which cases are similar and, in turn, should be placed in the same group or class. But what should those elements be? Research in biology does not offer much help here for other fields. Certainly the experience in botany and zoology suggests that using a small list of elements is likely to result in a poor classification; how one weights those elements can also distort the resulting classification, the issue of robustness (see below). Ultimately, though, the test of whether the elements used for classification are the right ones is determined post hoc by the quality of the resulting system.

What, then, determines whether a classification system is a good one? One set of requirements concerns the technical aspects of the system, such as whether it is stable and predictive with respect to characteristics. Suppose, for example, that the classification system is based on five characteristics of jobs. A stable system is one where those characteristics covaried perfectly with respect to the classification system; cases in the group all had each characteristic while no cases outside the group had any of the characteristics. Robustness is a related criterion. If small changes in the characteristics used to determine groupings or in the weights used for those characteristics lead to dramatically different groupings, then the classification system is not robust.

Further, what happens if one examined a sixth characteristic that was not used in the original classification? The system is stable if that characteristic behaved as did the other five. It is unstable if some of the individual cases classified into the group had that characteristic while others did not.

A second criterion of a good classification system is how well it deals with the discovery of new cases like the discovery of new taxa in biology or the creation of a new occupation. Systems where new cases do not fit into existing groupings have problems in the long-run that require major revisions. The frequency at which revisions are needed is surely one of the more objective measures of a poor classification system. (Note that systems based on the assumption of plenitude noted above should do better by this criterion as they are constructed to make room for new cases.)

A third criterion assesses how well the classification system does what it says it will do, that is, produce the information that it intends to produce. In other words, if a system suggests that the cases within a certain grouping will have the following characteristics, to what extent is it correct? A metric proposed by Gower (1974) has become the basis for making this judgement: First, partition a sample of cases within a proposed grouping. Then look for matches between the predicted characteristics and what one actually finds, coded as 0/1. The maximum number of matches (or in later versions its square) is a measure of predictive value that can be used to compare classification systems. Other methods, like cophenetic correlations, are similar in that they measure how well a hierarchy reproduces the similarities originally found in the population.

As Gower (1974) points out, this method reveals an important trade-off between predictability within classes and discreetness of classes: A system with a great many classes drawn narrowly will allow one to be more accurate about predicting the characteristics of the members within each class. On the other hand, it not only creates a more elaborate system but also leads to a situation where the differences between classes in the extreme become trivial, as noted above.

Farris (1974) suggests an algorithm for addressing this trade-off: the best classification system is one that produces the most parsimonious pattern of a characteristic that exists in the individuals of the group being considered and nowhere else. The emphasis in this system is on clear qualitative criteria rather than on criteria where the distinctions between individuals are a matter of degree. In other words, in order to use this criteria, it helps to have the kind of characteristics where what matters is whether they appear or not (e.g., having wings or not), qualitative distinctions, rather than characteristics where the important issue is a matter of degree, and quantitative (e.g., size or weight). Parsimony is certainly an accepted criterion for judging the worth of all kinds of theories and arguments, though, so it is no surprise to find that it should be a central issue in judging classification systems as well.

Statistical measures like these allow one to make comparisons between classification systems once established, but they do not necessarily offer much help in generating such systems. It is important to note that statistical techniques for measuring the similarities between cases, like cluster analysis or factor analysis, do not create classification systems. They may suggest groups of cases, but groups without a hierarchy are not a classification system. And an arbitrary hierarchy, that is, one not governed by objective criteria or rules, is not a classification system. To be specific, an arrangement that simply puts together jobs based on similarity on some dimension like an aspect of skill requirements would not be a classification system. Nor would it be very useful.

Other than measures of similarity, one frequently mentioned criterion for classification systems is that good systems are useful to the users. It is possible to have a system that is perfect from the perspective of the measures suggested above but that is largely irrelevant to users because it is based on criteria that are not of interest. The Linnaeus classification of plants that one sees written in Latin at botanical gardens conveys a great deal of information that is of interest to botanists, for example, but it is often of little use for gardeners. Partly as a result, gardeners often create their own, more ad hoc classifications of plants like "alpines," grouped according to growing characteristics, or "weeds," grouped according to attractiveness, to convey information about how plants are used in gardens.

Comparing Similarity and Causation as Criteria

As noted earlier, in addition to the criterion that groupings should allow users to make inferences about the individual cases in each group, a decision rule that turns on the similarity of cases, the other important criterion is that the groupings should reflect something about causation and the forces that led individual cases to be in their position in the classification system. In biology, phylogenetic classification systems, which use evolution as their decision rule, suggest where a particular taxa sets with respect to the history of evolution. The taxa within each group tend to be similar, albeit not as similar as in phenetic systems. But the similarities are the consequence, not the cause, of the classification system.

One important distinction between classification systems driven by similarities and those driven by causation is that the latter cannot be tested or verified in any obvious way. As the previous discussion suggests, it is relatively straight forward to think about judging the success of systems based on similarity. Measuring within-group and between-group similarities is conceptually easy, and making judgements about parsimony are as well, at least in principle. Systems driven by causation, on the other hand, simply map the theory onto individual cases. While it is possible to argue about whether one mapping does a better job of replicating the underlying theory than another, most of the interest concerns the theory itself.

Consider phylogenetic systematics, for example, where animals are grouped according to their location in an evolutionary pathway. There are some elaborate decision science techniques for judging how well a particular mapping of animals onto theory was done, but advances in classification -- indeed, the nature of the classification systems itself -- come down to field work and advances in the theory of evolution.

As a practical matter, cladists or phylogenetic systematists tend to focus their attention on characteristics with discrete states that are readily apparent and do not depend on a classification system for their observation. Pheneticists, in contrast, focus more on criteria that involve continuous variables with overlapping ranges.

Findings and Implications -- Developing Lessons for the S.O.C.: What Is Its Mission?

The arguments above suggest several general observations that apply to any classification system, including an occupational classification system:

- What basic decision rule should govern groupings and hierarchies, similarity or causation?
- How important is the ability to classify future jobs that do not yet exist?
- What trade-offs between parsimony and completeness should we accept?
- What criteria should be used to judge how "similar" individual cases in groupings should be?

The first issue to address in considering these questions in the context of the S.O.C. is to ask what we might want an occupational classification to do: What would constitute a "good" classification system?

One place to begin addressing that question is with a list of potential users and their interests. Drayse et al. (1993) provide a comprehensive list which is supplemented and reorganized below to illustrate more clearly who the users are:

I. Workers needing information about jobs
    a. those currently facing barriers (e.g., lack of education credentials) to getting jobs
    b. displaced workers with skills looking for new jobs
    c. workers looking for career advancement
    d. students/workers making choices about school and jobs

II. Employers
    a. interested in selection of applicants with the skills needed for particular jobs
    b. benchmarking of the establishment versus the labor market on issues such as wages or turnover
    c. human resource planning/comparing long-term skill needs to availability in the outside labor market

III. Counselling
   a. in schools for vocational counselling
   b. rehabilitation counselling
   c. litigation (discrimination, etc.) where labor market information is the benchmark

IV. Policy and research
   a. current and projected labor market trends
   b. integrating occupational and social information (i.e., income inequality)
   c. international benchmarking for competitiveness
   d. medical (i.e., occupational health) and other research

This list obviously includes a range of interests, and it would be a considerable coincidence if all of these interests were compatible. Consider how some of these interests relate to the two principles of classification noted earlier, internal consistency and causality. One set of interests might be described as benchmarking, learning about other jobs with similar skills or about what similar jobs pay elsewhere, comparing jobs with those in other countries, etc. These interests can be met with a classification system where the groupings are based on similarities almost irrespective of how the hierarchy is organized. But consider another set of interests that turn on information across occupations. Learning about career advancement opportunities, for example, requires that occupations be organized in ways that reflect promotion ladders in the workplace, that they reflect the causation of internal labor markets.

The second issue on the list relates to the earlier discussion concerning the concept of plenitude in the workplace. Specifically, how important is it to lay out a classification that will be able to accommodate new jobs as they are generated in the future? Are there any simplifying assumptions about what those jobs would be? The plenitude analogy from biology might suggest that virtually any job one could imagine will eventually exist or, what amounts to something similar, one cannot a prior predict the probability of any new job occurring.

As a practical matter, this issue relates to how classifications based on similarity might be devised. The simple method of creating clusters and classifications based on similarities among existing jobs -- based on the dominant characteristics of existing jobs -- may lead to a system that cannot easily accommodate new jobs. To illustrate, consider a system that might have been developed around the turn of the century where the physical manipulation of objects was perhaps the dominant criterion for differentiating jobs. Such a classification system would have a difficult time accommodating many modern jobs that involve conceptual material.[3]

The third and most important area also concerns issues associated with similarity. For example, in addition to various statistical tests to identify just how similar various groupings of occupations might be, a system of occupational classifications confronts the parsimony question noted above. Other things equal, a more parsimonious classification system is preferred as it is far simpler to use. But what should the trade-off between information and parsimony be? Groupings based on a single criterion in other fields seem to be unsuccessful for the reasons noted above. And highly differentiated groupings which make for great similarity within groups end up blurring differences across groups, increasing the complexity, and reducing the usefulness of the classification.

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[3] Conrad and Tonn (1993) generate something like a mental or intuitive classification system that might be more applicable to classifying jobs that do not yet exist.

Information from current users, considered below, suggests that parsimony and having a simpler system may not be that important a concern. Further, the interests of the various users are different enough that they may require substantially different information -- different classification criteria. And any simple system will make it impossible to accommodate those demands.

In the earlier discussion on biology, these issues took us directly to the question of usefulness, and in turn, to the criteria used for grouping observations. It is no surprise to find the same story with occupational classifications. Ultimately, the important factors driving the choice of an occupational classification system are going to be subjective judgements about usefulness and how to rank the priorities of the various users noted above and their competing claims. The place to begin that assessment is with an understanding as to what the Standard Occupational Classification system does right now, its perceived shortcomings, and long-term challenges any such system might face.

How Things Work Now

MacDonald and Hadlock (1993) describe the 12 criteria used for grouping occupations in the current S.O.C. Interestingly, it is not until the fourth criteria that one hears explicitly about putting similar occupations together. The first principle suggests the notion of causation discussed earlier, that the S.O.C. reveals the underlying occupational hierarchy in the workplace, generally within individual organizations. This principle seems to suggest that the logic of internal labor markets, what seems to organize hierarchy in most workplaces, is an implicit and important part of the framework of the S.O.C. The principles of placing apprentices and trainees in with the occupations for which they are being trained even more clearly reflects the principle of causation. That is, apprentices are grouped with their fully qualified craftsmen because that represents the career path. This arrangement may conflict substantially with the notion of similarity in groupings; apprentices in metalworking, for example, may in fact be more similar to and perform tasks that are more like apprentices in woodworking than they are like fully-skilled metalworking craftsmen. The fact that "helpers" are explicitly grouped separately from apprentices and from the craftsmen that they assist is perhaps the most explicit example of the causality classification principle. Helpers are grouped separately because, unlike apprentices, they will not advance to craftsmen jobs.

There are also rather explicit decision rules governing the importance of various criteria used for similarity. For example, the ninth principle governing the S.O.C. suggests creating separate groupings for supervisors and supervisees, clearly suggesting that the characteristic of "supervision" override other characteristics of similarity between occupations. As MacDonald and Hadlock (1993) note, the second principle of using work or tasks performed as the grouping criterion may well conflict with the third principle which is to use industry/place of work as a criterion.

A cursory review of the S.O.C.'s current classification criteria suggests first, that the decision rules are reasonably rich or complicated, depending on one's perspective. A fair amount of questions are required to classify a job. It is worth noting that the answers provide rather limited information on each aspect being examined because they ask "yes/no" questions about categorical variables such as whether the job is supervisor or supervisee, apprentice or fully qualified employee. The criteria do not reveal much about the depth or range of a given variable, about the level of autonomy given incumbents, for example, or the variance (as opposed to the range) or tasks performed. In this sense, the S.O.C. is more like the classification systems used by cladists (based on evolution) in biology than those used by pheneticists (based on similarity).

Second, the classifying criteria represent a compromise between the similarity and causality principles. Similarity here is based on tasks performed rather than characteristics of employees. And it seems fair to suggest that the principle of causation is the dominant one in the S.O.C., that it reflects the internal organization of work inside establishments and, in turn, the current structure of occupations in the U.S.

Current Shortcomings

The original purpose of the S.O.C., beginning with the Interagency Committee on Occupational Classification in 1966, was simply to help reconcile the different classification systems used by the government, especially the differences between the Dictionary of Occupational Titles and the classification system used by the Census. It is no surprise to find that an arrangement designed to reconcile competing systems does not always meet the idiosyncratic needs reflected in each of the original systems. As Drayse et al. (1993) point out, the S.O.C. was not built from field work but used the D.O.T. as its raw material. While the Census began using the S.O.C. in 1980, there remain important conflicts with other sets of government occupation data like the Occupational Employment Statistics (O.E.S.) collected by the states and assembled by the Bureau of Labor Statistics. As McElroy (1993) and Loewenstein and Manser (1993) discuss, for example, the O.E.S. places greater emphasis on functions performed than does the S.O.C.

As noted earlier, the central conceptual problem with any classification system is to convey as much information about the individual cases in as parsimonious a fashion as possible with the tradeoffs being governed by that subjective notion of usefulness. An occupational classification system that is based on material as rich as the D.O.T. faces more obvious trade-offs than usual because it is so much easier to see the kind of information from the S.O.C. that is not included in the taxonomy.

What would be most helpful in beginning an assessment of the usefulness of the current S.O.C. choices with respect to classifying occupations would be to ask current users of the S.O.C. It is important to remember that the audience is not simply current users, however, but also potential users. Absent information about current users, the next best approach is to see what users of the raw material -- the D.O.T. -- believe is most important to them. Users of the D.O.T. are not necessarily the same as users of the S.O.C., but this kind of comparison might reveal something about the interests of people who do not currently use the S.O.C. yet might if it were organized differently.

The Westat (1993) survey of D.O.T. users is the place to begin. Its results suggest that knowledge of skills required by occupations was overall the most important issue for users. The transferability of skills between occupations was a central issue. The fact that most respondents also used other sources of information to learn about the transferability of skills suggests an untapped market. Information on career paths was of somewhat less interest. In general, there were many items that were of intense interest to some users but not to others, suggesting the demand for customizing the information.

Dymmel's (1992) analysis of user responses to the interim report on the D.O.T. finds that interest was greatest for identifying the specific vocational preparations required for jobs, less interest in information related to career progression, and a preference for customizing the levels of aggregation to specific users.

Drayse (1993) also interviewed some users about the S.O.C. system. Their main interest was to be able to gather labor market information, not a surprise given that this is mainly what is reported by the S.O.C. With respect to information about the actual jobs, skill requirements were most important, followed by information on the tasks performed and then on the industries in which occupations were housed. They were also less interested in information on career paths and perhaps least in the organizational context in which the jobs existed.

What these results seem to suggest is that the main organizing principles behind the S.O.C. classification system are not the ones that users seem to care about. While the S.O.C.'s main goal is to reflect the occupational structure in the workplace, relying largely on internal labor markets and career progressions (and to a lesser extent tasks performed) to generate that structure, users seem most interested in skills required for occupations. Skills are not an explicit part of the S.O.C.'s organizing principles which suggests a problem even for those who currently use the S.O.C.

Employer Interests

It is worth an explicit discussion of how employers might use the S.O.C. and the material presented with it not because the interests of employers are necessarily more important than those of other potential users but because they are so ubiquitous.[4] A large proportion of the interests that individuals and counsellors have in occupational data, for example, is in trying to discern what employers need in terms of skills. As Sherwood (1994) notes, the experience in the United Kingdom suggests that if employers pursue a particular issue or embrace some standard, the other players in the labor market follow.

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[4] Unions may have their own interests in occupational data, but a large part of their interest comes indirectly through their influence through collective bargaining on employment decisions.

Employers routinely do their own internal classifications of occupations which begins with job analysis (identifying the content of jobs) and ends with job evaluation (grouping jobs into hierarchies). The most important reason for this classification is to determine pay levels. Job evaluations are useful in deciding which jobs demand the most and should be paid the most. The idea is to have a system of pay that is internally consistent, with jobs that have some greater compensatible factor (i.e., greater demands, skill requirements, tasks that demand compensating differentials, etc.) receiving being paid more.

Employers need information on pay rates elsewhere to set their own wages. Information on how their jobs compare to others in the labor market and, in turn, on what those other jobs pay is vital. Compensation consulting companies exist in large part to help employers compare their jobs with those in the labor market and gauge their relative wage position. Employers would be delighted with an occupational classification system against which they could benchmark their jobs to learn about labor market information such as average wages and hours, turnover, etc.

In addition to learning about labor market trends, employers also do job analyses to identify the skill requirements of jobs that will assist them in hiring. Once they know what a job requires, employers are in a better position to judge applicants. An occupational classification system could help them make those judgements. If it was easy to compare jobs with those in the classification system, then an employer would find it much easier to assess the relevance of an applicant's prior work experience. Similar arguments also apply to an employer's interest in human resource planning. Where jobs are easy to compare to a classification system, employers can assess their projected requirements for workers and skills against labor force trends and decide, for example, whether it was better to develop certain skills inside the organization or hire them from the outside.

The benefits of a classification system to hiring and planning increase if that system was linked to a set of skill standards and credentials, where the skills required for each occupation were identified and matched against an individual's credentials. Such a system would in theory greatly improve the quality of matches between employer and employee/reduce mismatches, reduce the need for screening and selection tests and overall selection costs. Overall, these efforts would also reduce frictional unemployment by improving information about jobs and applicants.

In practice, however, these benefits would be difficult to achieve. The easiest change required would be to adjust the classification system to focus on similarity of jobs for purposes of labor market information. That means moving away from the criterion of causality and toward that of similarity with particular emphasis on characteristics of jobs that translate across employers. Some large part of the new focus would have to be on skill requirements or tasks defined specifically enough to reveal skills (see the separate paper on worker/task characteristics). There are many aspects of jobs that are unique to the employer. These idiosyncratic skills cannot be compared across employers which means that the labor market information available will always be somewhat incomplete.

The second change is that in order to make use of the classification system, employers would have to adjust their own job analyses to make them comparable to that used by the government classification system. The government system would now have a potentially huge impact as it may well shape the internal organization of establishments across the economy -- how individual jobs are defined, how they are grouped into a hierarchy, etc. The reason that this matters is that job analyses and subsequent job evaluations serve internal purposes in addition to getting information on the labor market. The coercive pressures associated with a standardized system would be a mixed blessing. The standard occupational structure in the economy as a whole may not fit very well what one sees in any individual organization. Forcing a fit may lead to important distortions within the organization.

To illustrate the problem, consider the arrangements for internal promotions and employee development within any given establishment. At least some part of the hiring requirements for any entry level job might be expected to reflect the ability to move up to the next level. It is highly unlikely that the internal labor market of any individual establishment -- including promotion criteria -- would fit the standard occupational structure for the economy as a whole.

The most likely alternative would be a flexible system of classifications within individual organizations where the arrangements mimicked the standardized system with some local variations. No doubt an entire industry would spring up that would allow companies to cross-walk between their system and the government's standardized classification and data.

As Gottfredson (1994) points out, the benefits of standardized information and arrangements for employee selection also run into a series of legal obstacles associated with protective labor legislation. In brief, criteria used for selection need to be focused on each specific job, not on standard occupations elsewhere, in order to meet tests of job relatedness. The Americans with Disabilities Act in particular requires that skill assessments be tailored to the fit between specific applicants (related to any potential disabilities) and specific jobs. Occupation-based standards are prima facia in conflict with those requirements.

A further problem, as several authors have pointed out previously, is that identifying what is a relevant "skill" is a very tricky operation. Such a judgement should ideally be based on validation studies that show a relationship between the skill and job performance and not simply observations about what current employees do. Even given such validation studies, what level of skill should be required where the skill (as in most cases) is not something so straight forward and simple that one either has or does not have it. Should the standard be the level required for adequate, average, or superior performance, however those might be measured? For example, the International Standard Classification of Occupations (ISCO) uses level of competence in tasks as a classifying criteria, raising the thorny issue of measuring competence and then setting a level for it. Then it falls back on the level of education required to fill a job as the measure of competence which is more tractable but hardly solves the problem given that what is "required" to staff a position depends on what is available, the supply of labor (see Bertrand 1993).

Other Issues

As Rosenthal (1993) notes, the current S.O.C. and other government occupational classification systems, notably the Current Population Survey and the Occupational Employment Survey, are not perfectly compatible, and it can be difficult to cross-walk between them. (Although Dempsey (1993) argues that the compatibility may be greater than one might have guessed, a 98 percent match between S.O.C. and Census classifications of jobs.)

Another issue concerns the basic notion of revisions. When a classification system is altered, it becomes more difficult to make comparisons over time between data collected under the original system and that collected under the new system. Here the issue is how important trend data is as compared to current data: Revisions are more easily accepted when it is more important to classify current arrangements more accurately. Some systems, like the Standard Industrial Classification, are updated routinely with cross-walks used to make comparisons over time. Scopp and Priebe (1993) argue against major revisions in the S.O.C. that would impinge on the ability to make comparisons with earlier Census results.

Is the World of Work Changing?

Many of the arguments for revising the way occupational data are collected turn in part on assertions about how jobs are changing in the U.S. economy. Among the most explicit of these positions are those put forward in some of the background papers for the establishment of skill-based standards (Tucker 1994; Packer 1994) and, to a lesser extent, for the revision of the S.O.C. (Van Erden 1993).

The arguments take several forms, but surely the most important of these suggests that the economy is changing in ways that are raising the skill requirements of jobs. Most begin with the analysis from Workforce 2000 which concludes that the distribution of employment across occupations and industries in the U.S. is shifting toward higher-skilled work. Examinations of Census occupational data over time suggest, however, that the rate at which this shift has occurred has been slowing down from the 1960's to the 1980's (Howell and Wolfe 1993). Further, reanalysis of the data used in Workforce 2000 indicates that the anticipated shifts in the future will not in fact increase skill demands by much (Mishel and Texiera, 1992).

The more compelling arguments concern not changes across the distribution of employment across jobs but changes within individual jobs because of revolutions in the way that work is organized. The common theme in all models about new work systems is that they represent a contrast to Tayloristic work systems associated with scientific management. Changes in the organization of work matter for systems of occupational classification because these changes alter the hierarchy and internal organization of jobs in the economy. To the extent that a classification system reflects the causation principle described earlier, it is based on some theory about how work is organized. The S.O.C. has in part reflected the organizing principles of scientific management or Taylorism as they drove the organization of work in U.S. industry. The clear separation between supervision and execution in the governing principles of the S.O.C. noted above is perhaps the most obvious example.

The contemporary debate about these new models of work in the U.S. began by identifying "high performance" (HP) work systems in the context of new production systems: "lean" or high performance production systems were identified, and the work systems demanded by them were identified, by definition, as high performance work. These production systems are most clearly associated with Japanese manufacturing and include techniques such as statistical process control, just-in-time inventory systems (JIT), continuous improvement, and total quality management. This approach is, not surprisingly, the one taken by research projects that focus on production such as MIT's auto project[5] or a recent study of manufacturing conducted by the National Academy of Sciences.[6]

The models of lean production basically argue that increased quality, productivity, and flexibility can be obtained by making better use of employees. In particular, responsibility and decision making are transferred from administrative structures directly to employees or to their teams (see below). These arrangements demand significantly more from employees than do work systems associated with scientific management where tasks are narrowed and virtually all decision making is in the hands of management.

These new work systems are associated with a series of specific work practices such as employee empowerment/participation in decision making where employees take over some tasks previously performed by supervisors, engineers, and staff specialists; Teamwork where autonomous or semi-autonomous teams take over some direct supervision and substitute for formal management structures; Job rotation/cross-training where employees within teams swap tasks and become more interchangeable.

Measuring the incidence of these work practices turns on how they are defined. Identifying specific work practices creates a different metric than would looking for a set or collection of practices. Further, what percentage of the workforce needs to be included in a program like quality circles in order to count it as a high performance workplace? Lawler, Mohrman, and Ledford's study of Fortune 1000 firms in 1987 and again in 1990 provides extensive breakdowns of practices.[7]

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[5] See John Paul MacDuffie and John F. Krafcik. "Integrating Technology and Human Resources for High Performance Manufacturing: Evidence form the International Auto Industry", in Kochan, T.A. and Useem, M. (eds.), Transforming Organizations. (New York: Oxford University Press, 1992, pp.209-226.)

[6] See J.P. Womack, D.T. Jones, and D. Roos. The Machine That Changed the World: The Story of Lean Production. (New York: Rawson Associates, 1990) and Human Resource Practices for Implementing Advanced Manufacturing. (Washington, D.C.: National Academy Press, 198[illegible]

[7] Edward E. Lawler, III., Susan Albers Mohrman, and Gerald E. Ledford, Jr. Employee Involvement and Total Quality Management: Practices and Results in Fortune 1000 Companies.

Twenty-five percent have no employees involved in job redesign, 13 percent have a majority of the workforce in quality circles, and 22 percent in some other participation group; 12 percent have a majority of employees receiving team-based incentive pay; 68 percent have a more than a majority of employees involved in cross-training.

Osterman's 1992 survey reports that about one-third of firms have some significant level of the practices associated above with high performance work. Forty percent have a majority of the workers in the "core" of their production process in teams and 26 percent in job rotation.[8] Bassi's 1992 survey finds that half of non-manufacturing firms and three quarters of manufacturing firms have undergone some reorganization of work along the lines of these practices, although very few have made substantial changes.[9] A just released survey conducted by the Census for the National Center on the Educational Quality of the Workforce (EQW) finds that between 20 and 30 percent of establishments surveyed had some combination of these practices.[10]

What Skills Do the New Systems Demand?

Whether these new models of work organization are changing skills -- and if so, in what way -- is a central question for advocates who believe that we need to change how occupational data are collected. Closer inspection suggests that the changes in skill demands are not really so obvious. Consider, for example, the issue of autonomy, a key concept of participative work systems. As Klein[11] observes, just-in-time inventory systems that eliminate buffers of materials or intermediate products between work groups make those groups highly interdependent; changes in the production arrangements within any individual group can change their work pace, causing either shortages or pile-ups of material downstream. Because the overall flow of work across all teams in the assembly process must be absolutely consistent, the autonomy that any individual team has to make changes in work organization is tightly constrained.

(San Francisco: Jossey-Bass, 1992.)

[8] Paul Osterman, "What Determines the Introduction of New Work Systems?" Industrial and Labor Relations Review, forthcoming.

[9] Laurie Bassi, "Reorganization of Work and Workplace Education: Scope and Impact," (Washington, D.C.: Southport Institute, 1992.)

[10] See "First Findings: Results of the EQW Employer Survey." (Philadelphia, PA: National Center on the Educational Quality of the Workforce (EQW), 1995.)

[11] Klein, J.A. "The Human Costs of Manufacturing Reform," Harvard Business Review, vol.42, no.2, 1989, pp.60-66.

Further, as Adler[12] discovered at the New United Motor's (NUMMI) joint venture between Toyota and General Motors, the principle of continuous improvement requires that the performance of individual tasks be completely routinized so that the work teams can discover whether minute changes in tasks lead to an improvement in performance. In this sense, continuous improvement in work processes is like a laboratory experiment where everything is held constant except the one change being investigated. For employees, individual tasks appear to be every bit as rigidly defined as under scientific management. The fact that the work teams themselves ultimately control the design of those tasks may make the system more palatable, however.

My study of changes in skill requirements used data obtained on 56,000 production workers over an eight year period. These data suggest significant upskilling across the board for production jobs as measured by changes in Hay points, the job evaluation metric introduced by Hay Associates to measure job requirements. Some of the upskilling seems due to the fact that tasks associated with quality control and housekeeping have been pushed onto all the remaining jobs (the decline of employment in quality and housekeeping jobs is consistent with this interpretation). That is, not only has each job experienced upskilling but the overall distribution of production jobs has shifted away from less skilled and toward more skilled positions.[13]

Lean production essentially eliminates some jobs and pushes their tasks onto production workers. Some of those tasks, such as housekeeping, add little to the job. Other tasks, such as coordinating job design changes across teams, demand considerably higher skills, especially behavioral skills (communication, negotiation, and group dynamics skills). Adler notes that many of the tasks previously performed by industrial engineers, such as job analysis and redesign, are now being pushed down to the production teams.[14]

It is also important to remember that while these skill requirements are rising, they start at a low base. Data from Hay Associates suggests that a typical management job, for example, has skill levels about twice those represented by the production work here. Given the low base, it is certainly possible that workers already have the skills to meet the increasing skill demands represented by these data.

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[12] Adler, Paul S. (1993), "Time-and-Motion Regained," Harvard Business Review, vol.44, no.1, 1993, pp.97-108.

[13] These results are taken from Peter Cappelli. "Are Skill Requirements Rising? Evidence for Production and Clerical Jobs." Industrial and Labor Relations Review, April 1993. The skill changes for all job categories are statistically significant based on conventional nonparametric tests.

[14] See Adler, op.cit.

Is there 'Upskilling' Outside of Production?

By definition, the techniques of high performance production systems are associated with production work, and not all of these techniques apply directly to other industries. The equivalent study to the one noted above using Hay data for clerical jobs finds no consistent pattern; some clerical occupations show increases in skill while others experienced decreases.[15] The recent EQW survey noted above found a majority of employers asserting that overall skill requirements have risen in their organizations. (It is not obvious how valid these responses are given the subjective nature of the responses where "skill" is not defined, for example, and can easily be confused with performance requirements.)

One important attribute of these high performance systems is the increased flexibility needed to handle variations in products. Situations that do not demand change -- indeed may punish it -- may not make great use of these techniques. There is relatively little use of HP production techniques in industries like transportation, distribution, or public utilities, perhaps because reliability and consistency are the prime considerations there. Indeed, the work systems in these industries are often referred to as "high reliability" systems.

One of the more curious findings, however, is that there is little evidence of work practices associated with high performance production systems even in organizations that have production-like aspects. The processing of transactions in the back offices of financial services and related industries, for example, looks very much like an assembly line (more people are employed in these industries than in manufacturing). Yet there appears to be little -- if any -- evidence that HP production practices or even specific HP work practices are being used in these operations. Indeed, the effort in these facilities seems to be quite strongly in the opposite direction; to automate employees out of the process altogether.[16]

It is not obvious that there is a common trend in service jobs. In health care, for example, anecdotal evidence suggests that the biggest development has been efforts to deskill jobs along the lines of Taylorism: Many of the simple tasks traditionally performed by nurses are now being transferred to lower-skilled workers. In customer contact jobs in retailing and hospitality, there are some efforts to "empower" workers by giving them more authority to solve problems. Overall, there appears to be a clear trend toward high performance work in production-oriented jobs because it is associated with a new production process. It is not clear that this movement will make equal progress elsewhere.

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[15] These results are taken from Peter Cappelli. "Are Skill Requirements Rising? Evidence for Production and Clerical Jobs." Industrial and Labor Relations Review, April 1993. The skill changes for all job categories are statistically significant based on conventional nonparametric tests.

[16] Preliminary findings from a study of transaction processing at the Wharton School's Financial Services Center finds virtually no evidence of these practices.

What Skills Have Changed?

In situations where new work practices are in place, how have the jobs changed? Consider, for example, the tasks transferred to work teams in high performance work systems in a manufacturing environment. The systems of performance measurement and control are already in place as is the existing job design. The task facing the teams is simply to learn how to interpret information from the system in order to look for ways to improve it. They are not designing and setting up a new system. Further, because these decisions are made in teams, it is not necessary for each worker to have all of the skills needed to handle every task, only that those skills be available somewhere in the work group, perhaps spread across different individuals. For example, not every worker in the group needs to understand how to use statistical process control techniques. If one person understands the notion of confidence limits, another can read the charts, and a third knows their machine tools well enough to troubleshoot when the problems have been identified, they have a team that can make the technique work.

Another study examines the relationship between these new work practices and skill needs using data on jobs from the public utilities industry.[17] The workers were asked about the skills they needed to improve performance in their jobs and also about the extent to which they used work practices associated with high performance systems. The overall results suggest that there are some, although not many, significant differences in skill needs associated with high performance work. And some of the differences suggested that skill needs were actually lower where there was more high performance work. For example, skill needs were lower where certain team processes were in place, perhaps because individual workers must function on their own and make more decisions by themselves. As a result, each worker would need more knowledge and skill to perform a given task than when that task is performed in a team where knowledge and skill can be pooled across team members. Overall, the skills that tended to be associated with these new work practices are behavioral skills such as working in teams.[18]

These results suggest that while new work practices may make new demands on worker skills, the demands may not be overwhelming, and they may focus more on behavioral skills than on traditional vocational skills. Thinking specifically about "lean production" systems in manufacturing, the fact that Japanese auto companies can take inexperienced workers in the U.S. and the U.K. and produce autos more efficiently than can German companies in Germany where craft work skills are thought to be much higher suggests that the skills required by lean production in particular can be taught relatively easily. New production systems may require learning about concepts such as continuous improvement and statistical process control, but much of the training in Japanese auto companies in particular is with these behavioral skills and socialization.

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[17] See Peter Cappelli and Nikolai Rogovsky, "Skills and Individual Performance," Philadelphia: National Center on the Educational Quality of the Workforce at the University of Pennsylvania, working paper , October 1993.

[18] See Cappelli and Rogovsky, op.cit. for additional analysis of these data.

Two other developments related to these trends in work organization are changes in the organizational structure of establishments. The organizational chart that represents the hierarchy inside organizations is getting flatter as the "middle" positions are cut back. Empowerment and team work trends noted above help reduce the need for supervisors, an effect that spills over to higher management (i.e., fewer managers are needed to direct supervisors). New information and control systems automate the compliance functions typically directed by middle managers. And the move toward decentralization -- profit centered operations, e.g. -- reduces the importance of compliance. Flatter organizational charts means shorter job and promotion ladders inside the organization. The positions that remain, in turn, become broader.

An overall summary of how work may be changing includes the following conclusions:

* Work practices are changing with more establishments using teams, employee participation, and other such arrangements. But these arrangements are by no means in all industries and occupations and are not yet close to being in a majority. While the prospects for increased diffusion look good, there are also important reasons for believing that there will be limits to the spread of these practices.

* Where new work practices have been introduced, skills appear to be higher; although, how much higher is hard to gauge, and the skill demands that have increased seem to focus on behavioral skills.

* With respect to the nature of these new skills, new production techniques like lean production change jobs by broadening them, eliminating certain narrow jobs, and loading their tasks onto others. Teams, employee participation, and the other more popular new work practices often lead workers to move across a much wider variety of tasks that often includes supervisory tasks.

* Many of the above changes make it increasingly difficult to use tasks performed to define or differentiate occupations. First, the set of tasks that a given worker performs is now much broader and more likely to overlap with what workers do. Second, to the extent that workers do have a core set of unique tasks, those tasks may now take up a much smaller proportion of their working time.

Trends on the Horizon:

The next wave of innovation in work organization is again associated with manufacturing, so-called "quick response" production, basically amounts to customized production where output is essentially produced for specific orders rather than for inventory. Products and production runs under this system change constantly. And the pace of this change requires a different system of production. The faster changes and smaller production runs these systems require mean that mass production systems of work organization are too slow to change and too expensive per production run.

Quick response systems, therefore, turn production over to a smaller team of workers with higher skills and flexible tools. The team may not be as efficient as the assembly line for a given product, but they can adjust to variations in products without substantial retooling. Their quick response to product changes allows producers to follow customer tastes more closely. Because workers in this system perform more tasks, they need a wider variety of skills. Further, each worker has more autonomy because the work flow is not as tightly governed by an assembly line. The Japanese firms that are the leaders in quick response manufacturing actually see some production tasks shifting back from machines to workers as a result of quick response systems.

Another way to describe these developments is that quick response pushes more of the control of production on to individual workers because of limitations in the flexibility of current machine tools and production technology. It is difficult to imagine that improvements in technology will not erode the advantage that skilled production workers have in flexibility over more automated approaches. Industries with longer production runs like autos have already found it cost effective to create machine tools and assembly line techniques that provide considerable improvements in the flexibility of production.

Other developments seem to cut in a different direction. There appears to be a weakening of internal labor markets and decline in the attachment between employer and employee. The growing use of contingent employees and subcontractors, reductions in job security associated with downsizing and restructuring efforts, and increased mobility across organizations -- especially for managerial employees in large organizations -- suggests the nature of this change.[19]

Together, the arguments above suggest that there are important changes going on in the workplace although they may be less than revolutionary. The spread of high performance working arrangements raises skill levels somewhat. In particular, they give prominence to interpersonal skills and the ability to work in teams, communication skills, and problem solving abilities. Changes in the organization of work seem to be eroding the basic scientific management approach, especially the division between supervision and execution of tasks. A revised occupational classification system needs to pay more attention to the behavioral skills and to develop a logic for organizing work into hierarchies that are more flexible than scientific management.

Changes in the structure of organizations with respect to employment and the potential weakening of traditional internal labor markets make different demands on a classification system. These developments suggest a greater need for labor market information about jobs and about workers that can help in making matches. If there is more movement of employees across organizations in the future, then the problems of employee selection become even more important. Selection is complicated considerably by the arguments noted above which suggest that jobs may be becoming more unique and idiosyncratic across organizations.

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[19] These changes are described in Peter Cappelli (ed.) Change at Work. New York: Oxford University Press, forthcoming. A summary version of the arguments can be found in "Restructuring Employment," Looking Ahead (Washington, D.C.: National Planning Association, Fall 1994.)

Alternative Systems

There is a clear sense from the above arguments that some greater emphasis on skills is important to a revised classification system in order to address changes in the workplace. An emphasis on skill could be reflected in the two basic principles for developing classifications -- similarity and causality. Occupations could clearly be grouped by similarity of skill requirements. Hierarchies of occupations could be formed in part based on a hierarchy of skills. One criterion for such a system would be to structure the hierarchy based on how skills are acquired, reflecting traditional internal labor market and craft-based systems of work organization. Another basic criterion would be to organize hierarchies along dimensions such as the depth or extent of skill one has.

Most countries that have recently revised their occupational classification systems have placed great emphasis on skill requirements as the classifying criteria. Such efforts confront a series of difficult choices, however.

Arguably no system places more weight on skills than Australia's. Madden and Tam (1993) describe the Australian Standard Classification of Occupations which is based on skill and reduces the total questions to three. Their measures, however, in fact do not measure skills but instead reflect credentials -- education, on-the-job training, and experience. As Sherwood (1994) notes, using academic credentials can raise important political issues as it can reinforce a segmentation of occupations by access to education. In France, this problem has led to efforts to cross-walk between traditional academic requirements for jobs and more vocationally-oriented preparations that might provide the same skills.

Some Complications with Skill-Based Systems

When many of the arguments above talk about skills, they in fact are referring to a whole package of employee attributes that contribute to the successful completion of tasks. This package of attributes is sometimes referred to as knowledge, skills, and abilities (KSA's). In practice, the policy interests may not be equal for all aspects of KSA's. The on-going work of the National Skills Standards Board, for example, has emphasized work-related skills that transfer across organizations and jobs, "cross-functional" skills, as well as those that can be learned in formal education and training.

It is clearly beyond the scope of this paper to describe all of the issues associated with developing a mapping of KSA's for occupations. But a brief review may be in order. The first issue concerns not only skills or KSA's but any employee-based attribute. In order to suggest that an attribute is an important component of a job, we would like to know that it is in fact related to performance in that job, information that comes from validity tests relating the KSA to job performance, for example, and not simply from job descriptions about what is common in a job.

A second issue concerns the basic notion that a useful set of general skills can be developed that cut across jobs. The National Job Analysis Study currently being performed by the American College Testing Program is designed to provide information about cross-functional skills (Korte, Nash, and Smith 1993). Several observers have doubts as to how effective the search for cross-functional skills will be. McCage (1994) puts forward one of the stronger objections. He argues that tasks and skills are really only meaningful in the context of clearly defined occupations and settings. Campbell (1994) is more optimistic but notes the trade-offs with respect to lost information that are involved in a classification of skills that is general enough to cut across occupations. Using education "requirements" as measures of skills, for example, is a common solution which virtually all observers find objectionable.

A third issue concerns which aspects of KSA's to consider and reflects the basic classification issue of parsimony noted earlier. As Harvey (1994) points out, it may be difficult in practice to distinguish between different aspects of skills -- what is knowledge-based or specific v. abstract, e.g. Each emphasis would lead to a different classification system. Harvey's conclusion about the lack of robustness of classification systems is to give users some choice as to the information that would be used to form the groupings to suit their own needs.

And finally, there are a series of methodological issues which basically reflect the fact that no system of classification currently conceivable will meet academic standards because the underlying research in these areas is not yet fully developed. For example, validity research on the relationship between skills and job performance is not very extensive. A less sanguine view is that waiting for academic research to develop answers to these questions is hopeless in that the current debates in part reflect differences in priorities and values which will not be resolved through additional research. The lack of consensus about the best systems for job analyses, for example, reflects in my view not a lack of research but different preferences concerning the inevitable trade-offs that classification systems demand.

The distinctions used in the D.O.T. between basic, cross-functional, and occupation-specific skills seem to be the most appealing criteria to use as a way of including skills into a classification scheme. They strike a reasonable trade-off between parsimony and richness and get at the labor market information that may become increasingly important. Campbell (1994) offers a good assessment of what is required to make such an arrangement work.

Implementation Issues:

Stevens (1993) and others have raised the important practical issue of the limits imposed on any classification system when it goes into the field. The issue of parsimony discussed earlier was applied from the perspective of the end user but also needs to be considered from the perspective of the agencies compiling the information. They have a very different interest in parsimony. Consider, for example, a data collection effort like the Current Population Survey where the Census has a fixed and relatively small number of questions it can ask. An occupational classification system that is ideal for the purposes of end users might contain a wide range of information about location in the promotion ladder, skill requirements, nature of the tasks performed, etc. Getting that information from a respondent is the issue as each additional piece of information is costly to obtain.

The current questions used for gathering information about jobs are far from ideal, however. The CPS asks respondents about their business or industry, the kind of work they do, and their most important activities at work (Census 1989). This is not a great deal of information about the job. Classification clerks then take these responses and code them into occupations. There are a number of tests for the reliability of the coding but not the validity of the original responses. There is compelling evidence that respondents' views on what their occupation is may not be especially valid. In about half the cases, employees believe that their occupation is something different than does their employer (Mellow and Snider 1985). At least half the time, then, one of the parties -- employer or employee -- is wrong in labelling an occupation.

In at least some data collection efforts, respondents give the interviewer their job title. Dempsey (1993) suggests that about 10 percent of employers for the O.E.S. survey simply submit their current job titles on Census data collection efforts. Researchers then use information from the D.O.T. or other sources to infer information about what skills are required for that job title, ultimately generating estimates for the sample about skill requirements and other issues. The problem, of course, is that the job title the respondent has in their organization may be idiosyncratic. It may not correspond at all well to the title that someone in another organization doing the same tasks may have; and their job description may be very different from what that title would imply using the Standard Occupational Classification titles. As noted above, organizations may be getting more idiosyncratic in their jobs titles, making it even less desirable to let respondents classify themselves.

Interviewers need to ask respondents directly about their jobs, and they need to ask more questions if a classification system is going to report different kinds of information. From the perspective of end users, a couple of pieces of information on skills, a few on the nature of tasks, and one or two on the position of the worker with respect to production systems or internal organization might barely scratch the surface of their needs. The amount of information that users want, however, would certainly swamp existing data collection efforts.

The experience in Ohio suggests some lessons for how a data collection system might be implemented. Sommers (1993) notes Ohio state agencies often found the D.O.T. too complicated to use and instead resorted to a series of keywords and computerized text searches for matching workers with jobs. The Ohio Bureau of Employment Services adopted aspects of the Canadian JOBSCAN system for mapping work-related skills that relies on simplified checklists, like keywords, that can be updated easily as jobs change. It is important to note, however, that this system is designed to facilitate current matches between employers and employees and not to provide consistent data over time. Flexibility and ease of updating is a priority here but might actually be a drawback elsewhere.

Stevens (1993) suggests a compromise between depth of information and costs of collecting it. Some occupations, the most important ones by some criteria, would be identified and described with a more highly elaborate set of identifying criteria and more information collected on these. A second set of occupations would be identified with a substantially simpler system.

Economics-based studies find that relatively simple classification systems can account for a large amount of the variance in job characteristics such as wages (e.g., Cotterman and Peracchi (1992). Similarly, Ree (1994) finds that cognitive ability alone explains most of the variance in individual job performance. It is not clear how useful such information is for designing classification systems, however. The information end users require is multidimensional and considerably richer than just wage rates or earnings. As noted above, it includes skill requirements, tasks, position in hierarchies, etc. And accounting for the majority of the variance in a sample along one dimension is different than being able to identify individual cases with precision. The fact that diminishing returns apply to additional criterion in a classification system should not be a great surprise. What one might learn from each additional classifying criteria is less and less, but the information needs cannot be met by a single criterion.

Conclusions and Recommendations: A Modest Proposal

Most of the more difficult issues noted above concerning the principles of designing classification systems occur because of trade-offs associated with having to pick a single system. Compromises between the interests of different users are the most obvious example. A grouping based on similarity of skills, e.g., may not reveal much about promotion and development prospects. Further, classification systems are often not very robust, and this is likely to be especially the case with occupational classifications where the competing criteria (i.e. skills, tasks performed, industry) are quite different. As a result, compromises between criteria and interests may prove especially unsatisfying.

The breakthroughs in occupational classification systems in the past, I believe, have been to expand the information available to users by changing the form of the presentation. Scoville's (1969) was certainly among the first efforts to present information about jobs in a matrix form. The National Occupational Classification of Canada (see Roberts 1993) is notable in part because it incorporates some aspect of skill into the classification system but also because of its matrix presentation that relates jobs to skill type (type of work performed) and skill level at the same time.

Perhaps the most important development in recent memory in the U.S. with respect to job-related information has been the revision of the Dictionary of Occupational Titles into a database form. The most important aspect of this revision, I believe, has been to break classification efforts out of the box of two dimensional information reporting imposed by a sheet of paper. Different users can access a wide variety of information from the new Database of Occupational Titles in very different ways.

Any occupational classification system must be compatible with and ideally should be based on the criteria and information used in the D.O.T. (The job titles used, for example, should be those from the D.O.T.) The D.O.T. now offers a wider range of options in the design of an occupational classification system. What would be ideal, I believe, is for the revised S.O.C. to offer at least some of the flexibility that the new D.O.T. presents.

A revised S.O.C. begins with the descriptive information about jobs collected through surveys conducted by the Census and the B.L.S. Classifications are only as good as the information on which they are based. As noted in the implementation discussion above, the range of information that describes a respondent's job has got to be expanded if the classification system is to convey more information. Including skills along the dimensions noted earlier seems an important addition.

Once the additional information is in hand, then the government has to make choices about how to use it to form a classification system. Just as the new D.O.T. allows users to cut its information in different ways, the sophistication of modern data bases make it possible to generate several different occupational classification systems from the same set of descriptive information about jobs.

For example, there seems to be a clear demand for a classification based on skills similarity that would make it easier to learn about labor market issues. There is also a clear and continuing demand for an industry-based classification that would map onto existing industry data. These two classifications are not obviously compatible. A matrix not unlike the Canadian version could make it possible to see how a given job fits into both a classification of skills and a classification of industry. Having two separate systems requires no new data and makes no more demands on implementation than would a single, compromise system.

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Systems for Classifying Occupations Based on Supply and on Demand

by

Peter Cappelli[1]

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[1] Co-director, National Center on the Educational Quality of the Workforce (EQW) at the University of Pennsylvania. This manuscript was prepared for the Standard Occupational Classification Revision Policy Committee charged with revising the Standard Occupational Classification System under contract to DTI. The views contained are solely those of the author and do not necessarily reflect those of the Committee.

Task-based systems have perhaps the most difficulty in addressing jobs where creativity and ingenuity are required as it is difficult to describe the tasks needed to achieve outcomes that cannot yet be articulated.

But there are also some difficulties inherent in trait-based systems, in addition to the basic problem noted above of that it is difficult to use them to identify real jobs in the economy. First, such arrangements might have a very difficult time handling the context issues that are central to differentiating occupations, leading to situations where trait-based analyses do not adequately differentiate occupations. Another practical problem with trait-based job analyses in the U.S. context concerns protective labor legislation. Specifically, the statutes and case law on issues like discrimination turn very explicitly on task-based definitions with which trait-based systems are likely to conflict.

Conclusions

Research on systematics in other fields suggest that single-criterion approaches to classifications -- in this case, either supply or demand-based -- do not produce useful classification systems. They are not robust, and they impose severe trade-offs on the interests of diverse users.

The same conclusion seems to hold here. It seems necessary to have some aspects of demand-based, or more accurately a task-based criterion, simply to identify real jobs in the economy. A classification system is not very useful if users cannot associate actual jobs with it. In addition, many arguments about the importance of worker interests and the way that jobs may be changing in the economy suggest that greater importance be given to supply or trait-based criteria.

Perhaps the most important conclusion from the more practical research on job analysis is that task and trait-based systems may not be very different, at least for tasks that are straight-forward. Much of the general concern about trade-offs in benefits between different classification systems may therefore be misplaced.

Finally, at least some work context criteria are needed in a classification system to get at other, important issues. Perhaps the most obvious of these is to learn about promotion opportunities. A classification system that reflects something about actual job hierarchies, that grouped jobs based on career progressions, would help convey that information.

A system based on task, trait, and context criteria may sound complicated; but, compared to classification systems in other fields, it is reasonably straight-forward. Some combination of task, trait, and context criteria in developing occupational classifications may actually do a better job of delivering on the kind of promises made for the substitution criterion than would a system based on elasticities of substitution. And it would also be able to deliver a great deal more information for other users.

between occupational groups. The research that has been done is mainly in fields like sociology where the clear suggestion is that factor prices, the issue of concern to economists, may not even be among the main considerations.

If, for example, the elasticity of substitution between managers and front-line workers is low in manufacturing and high in services, it is not clear what would be gained from knowing the average elasticity in the economy as a whole or from a classification system based on such averages.

Some of these arguments suggest that an occupational classification based on elasticities of substitution should include both the elasticity generated from the production function (the demand side) and an equivalent elasticity generated from worker preferences (the supply side). But there is no reason to think that any classification based on worker preferences would coincide with a classification based on the ability to substitute from an employer's perspective. It is the intersection of worker preferences and technical substitution capabilities -- demand and supply -- that determines whether and how workers move across jobs.

In addition, it is impossible to know what a substitution-based classification system would look like a priori as the groupings would only be revealed after the fact on the basis of production function estimates. Jobs that may be substitutes for the purposes of final outcomes through a production function may not necessarily have much in common with each other. For example, one could imagine that safety engineers might end up being substitutes for tort lawyers in certain circumstances where companies have the choice of reducing risks associated with products or facing litigation.

A classification system that grouped jobs together based on their substitutability as generated by production function data, even if it could be generated, would not seem to meet many of the tests of a "good" classification system as discussed in the previous paper. The only information that it would reliably convey is the rather esoteric elasticity of substitution as generated by production functions. Certainly this is of interest to employers, but so is a great deal of other information about occupations that such a classification system might not reveal. A variety of institutional factors such as trade union coverage could well create circumstances where occupations that were substitutes for the purposes of employers were nevertheless in very different labor markets. So groupings based on substitution would not necessarily be helpful at conveying labor market information.

More direct attempts at job analyses could end up doing something very similar by identifying aspects of jobs like skill requirements that translate across organizations. Such an effort might be superior even in principle to generating elasticities of substitution.

Using Similarity as a Criterion

Both the Canadian National Occupational Classification and the Australian Standard Classification of Occupations rely in part on employee mobility as a criterion for classifying occupations. This is not the same as the elasticity of substitution derived from production functions. How an employer might substitute occupations for each other is not at all the same as how workers themselves might move between occupations. Nurses and doctors, for example, might be close substitutes for each other from the perspective of employers, but nurses are far more likely to become administrators than to become doctors.

The Canadian system uses actual mobility patterns and is probably closer to a worker preference model than to an employer substitution model, although because it focuses on actual mobility, it really represents the intersection of the two, supply and demand. The Australian system, in contrast, puts together occupations based on task requirements and suggests how workers could move based on their current knowledge, skills, and abilities. This has a series of advantages over actual mobility. Patterns of mobility may change sharply over time, creating a need for major revisions.

A system based on actual substitution reflects all the current idiosyncrasies in the economy, such as licensing requirements, trade union agreements, custom and practice, etc. So a psychiatrist and a anesthesiologist might be in the same group where the classification system is based on actual substitutability because in terms of current licensing requirements the two are transferrable (i.e., the tasks in both require an M.D. degree). A system based on tasks performed might put psychiatrists and psychologists in one group, because the tasks they perform are highly similar, anesthesiologists and anesthetists in another.

The Australian system is an example of a demand-side system that groups jobs together according to the criteria of similarity, rather than substitutability, and gets closer to the general principle in systematics that items within a grouping should have common attributes. Such groupings would put together occupations that were somewhat substitutable from the perspective of an employer, although in this case it would be a consequence of and not the criteria for grouping.

An important criterion for an occupational classification system is to create groupings within which occupations are reasonably similar from the perspective of the employer. Trying to generate such a system from elasticities of substitution is, at present, impossible from a practical perspective and might lead to a series of perverse groupings. Groupings based on similarity of tasks performed is conceptually different but might in practice give employers something very much like the same thing.

Classification Based on Employee Characteristics

It might appear reasonable to consider whether classifications of occupations based on employee characteristics might be superior -- supply-side as opposed to the employer and demand-side criteria considered earlier. Efforts to develop classifications based on employee outcomes are fraught with problems, however.

First, labor market information is already readily available. It is attached to occupational classifications (e.g., "machinists" earn 'x' and have unemployment rate 'y'). Second, a classification system based on outcomes would be next to useless. Consider, for example, a system that grouped jobs by earnings. It would create occupational classifications such as "high wage" and "low wage" jobs. Jobs in the "high wage" category might well have nothing in common except earnings. Lawyers and plumbers might well be in the same group, for example. Information about what work was performed, what skills were required, or where the jobs stood in the system of work organization -- information usually provided in the context of an occupational classification system -- would now be lost. The classification system would convey no information other than what was already conveyed by labor market reporting. Third, the composition of the jobs in each category would change almost constantly with fluctuations in the labor market.

In terms of the principles of taxonomy, the issue of robustness discussed in the previous paper helps explain why this approach would be so peculiar. Classification based on outcomes would use a job criterion that a) is relatively hard to establish (most people cannot tell what a job pays from a simple description) b) does not covary that well with other job criteria c) changes relatively quickly. The system that is developed would then have to be used to report more qualitative criterion, like tasks performed or skills required, with which readers would be more familiar. In short, it would stand traditional classification principles on their head.

The issue of most importance from the perspective of a worker is what they need to have in order to be qualified for a job. The employer in describing a job might typically be thinking of tasks that need to be performed, some of which are quite specific and perhaps even idiosyncratic. The employee, in contrast, may well be unfamiliar with these tasks and is more typically thinking of the attributes they would need to be successful in a job.

The demand-side arguments seek to reveal information about the actual tasks that need to be performed. The supply-side arguments seek a classification system that will reveal information about the worker attributes that are required to do the job. The two in practice may not be that far apart.

Job Analysis

This distinction between demand and supply models, between tasks and attributes, is neatly replicated in the job analysis literature systems. Task-based analyses, from the demand side, focus on identifying the actual tasks that need to be performed and the behaviors required by the job. Trait-based analyses, from the supply side, looks at what individual workers need to have with respect to knowledge, skills, and abilities in order to perform a given job.

When tasks are straight-forward and easily defined, there appears to be very little difference between task and trait-based systems. Where tasks are not straight-forward, however, trait-based systems seem to have an edge. Where jobs are now broader (encompassing more tasks) and incorporating some supervisory tasks, not only are many more tasks required, but the tasks may vary considerably over time. A task-based system that listed everything one might be required to do in such jobs could be prohibitive; a system that tried to predict the "most common" tasks might well be defeated by a truly flexible arrangement for work organization.

Executive Summary

Abstract

The charge for this paper is quite specific -- to compare the relative merits of classifying occupations based on the characteristics of jobs versus the characteristics of workers. There is both a reasonably abstract literature examining this issue in labor economics and a very practical literature in personnel psychology. It seems generally to be the case that theoretical arguments suggest relatively easy answers while more applied research on the same topic reveals lots of thorny and complex issues. In this case, however, it is extraordinarily unusual (and fortunate) that something more like the opposite conclusion seems in order. While the more abstract arguments suggest a tough tradeoff between classifications based on jobs and those on workers, the applied research suggests that, in practice, the factors governing choices are reasonably straight forward. And in some cases, the two can amount to the same thing.

In order to avoid redundancy, the arguments in this paper assume the material has been read in my more general paper on "Conceptual Issues" also prepared for the Standard Occupational Classification Policy Committee, especially with regard to the basic issues confronting classification systems. The material presented below is designed to be read in conjunction with the earlier paper.

Economics Arguments

Economists have expressed the strongest interests of any academic field in attempts to revise the S.O.C. They have tended to argue that occupations should be grouped according to the extent to which they are substitutes for each other in the current economic environment. The jobs that are grouped together in an occupational category are similar on a range of dimensions, only one of which might be characteristics related to an employer's ability to substitute across those jobs. Unless the other jobs in an occupational category are similar on the substitution dimension, the data may not tell the employer much about what the labor market is like for their employees.

If jobs are grouped according to substitutability, then employees would more easily be able to see the other occupations where their skills could be used, as could employers who want to fill jobs and would have a better idea where to look. Second, such a system might more accurately reveal information about how production systems were changing, such as whether the price of skill was rising or falling. Occupational classifications that reflected elasticities of substitution would help with forecasting functions. In terms of research, a classification system based on the ability to substitute might map in a very straight forward way onto other government data like industry-level production function data from the Census of Manufacturing, for example.

Problems with Substitution

There are a number of very important practical problems with the argument that occupational classification should be based on an employer's ability to substitute across occupations. Much of the argument for this criterion turns on production function research, but it is not clear how advanced such research is. In particular, there have been few efforts to examine the elasticity of substitution

Purpose and Background

The charge for this paper is to compare the relative merits of classifying occupations based on the characteristics of jobs versus the characteristics of workers. There is both a reasonably abstract literature examining this issue in labor economics and a very practical literature in personnel psychology. While the more abstract arguments suggest a tough tradeoff between classifications based on jobs and those on workers, the applied research suggests that, in practice, the two may not be very different.

The arguments in this paper assume the material has been read in my more general paper on "Conceptual Issues" also prepared for the Standard Occupational Classification Policy Committee, especially with regard to the basic issues confronting classification systems. The material presented below is designed to be read in conjunction with the earlier paper.

The Economics Arguments

In an article that has become more popular over time, Cain, Hansen, and Weisbrod (1966) assert that economists as researchers have clear interests in the kind of information that a system of occupational classifications might reveal. What was novel about their argument at the time was the understanding that the kind of questions one might answer using occupational data depended not only on the nature of the data that was assigned to occupations, such as wages or unemployment rates, but the way that occupations themselves were defined and organized. In other words, the classification system itself mattered.

They argue that "the basic purpose of occupational classifications for the economist is the provision of information about factor substitution possibilities" (1966, p.49). What they mean by this is that occupations should be grouped according to the extent to which they are substitutes for each other in the current economic environment.

To illustrate, at present, an employer may employ workers in a relatively narrow job title that is included as part of a broader occupational category for the purposes of reporting labor market data. The data reported, therefore, are a kind of average of the experience of the different jobs in that category, and only a small part may reflect the direct experience of the job title about which this particular employer cares. Unless the other jobs in the category are similar on the substitution dimension, the data may not tell the employer much about what the labor market is like for their employees.

If, on the other hand, jobs are grouped according to substitutability, then the system so organized would offer the following advantages. First, employees would more easily be able to see the other occupations where their skills could be used, as could employers who want to fill jobs and would have a better idea where to look. Second, such a system might more accurately reveal information about how production systems were changing, such as whether the price of skill was rising or falling.

Third, they also argue that occupational classifications that reflected elasticities of substitution would help with a variety of forecasting functions, especially human resources planning -- a topic that is now less popular in public policy discussions. As a caveat, it is worth noting that different classification criteria would offer different advantages.

In terms of research, perhaps the main advantage of a classification system based on employer interests and that groups jobs according to the ability to substitute across them is that such information would map in a very straight forward way onto other government data. The most obvious candidate would be industry-level production function data like those that come from the Census of Manufacturing. (Groupings of jobs based on elasticity of substitution do not necessarily map onto other industry data any better than other groupings, however.)

Loewenstein and Manser (1993) describe the conceptual appeal of looking at classification systems from the perspective of either supply and demand, no doubt hoping for the same usefulness that these concepts have in understanding labor markets. Triplett (1993) puts forward some of the arguments that have been made by the Economic Classification Policy Committee in favor of using the ability to substitute as the classification principle. (Many of these advantages seem related to using consistent criteria, no matter what they are.) In particular, he notes how classifications based on production-oriented criteria may conflict with classifications based on substitution in use.

Findings and Implications

Problems

Much of the power of these economics-based arguments comes from the fact that they present some basic notions about what any classification system should do, such as reveal as much information as possible about the individual occupations in each classification and present information in consistent formats, and that they reveal some of the trade-offs of alternative classification systems. It is always important to ask, however, about the extent to which arguments are compelling on their own merits or because the comparisons chosen are weak strawmen.

The place to begin that assessment is by considering the trade-offs and problems with basing classifications on elasticities of substitution. First, in terms of implementation, the argument for classifications based on the elasticity of substitution between occupations needs to be based on detailed analyses of production functions with the appropriate prices for different factors used. When the Cain, Hansen, and Weisbrod (1966) article was written, there was considerable hope that research involving production functions would offer a wide range of useful results.

As a practical matter, however, it is not at all obvious how much new insight has been gained from production function research. While there is a great deal of work that uses production functions to estimate outcomes like performance, relatively little research has been done in economics on the choices that employers have as to how workers and equipment are combined. In particular, there have been few efforts to examine the elasticity of substitution between occupational groups. The research that has been done is mainly in fields like sociology where the clear suggestion is that factor prices, the issue of concern to economists, may not even be among the main considerations (see Kelly 1990, e.g.).[2] While the conceptual notion of organizing occupations by the elasticity of substitution is straight forward, the practical issues are anything but.

If, for example, the elasticity of substitution between managers and front-line workers is low in manufacturing and high in services, it is not clear what would be gained from knowing the average elasticity in the economy as a whole or from a classification system based on such averages.

A second problem with the notion of classifications based on the ability to substitute is that it seems to require a convergence of interests (or more accurately, a coincidence of interests) between employer and employee. The actual ability to move across occupations depends not only on the elasticity of substitution, as estimated by production functions, but also on worker preferences with respect to the attributes of jobs. It is not at all obvious how jobs would be grouped according to worker preferences given that preferences for many of the most important items are not that distinct but are relatively similar -- most workers want higher wages and benefits, more pleasant working conditions, etc.

Cain, Hansen, and Weisbrod (1966) suggest that an occupational classification based on elasticities of substitution should include both the elasticity generated from the production function (the demand side) and an equivalent elasticity generated from worker preferences (the supply side). There is no reason to think that any classification based on worker preferences would coincide with a classification based on the ability to substitute from an employer's perspective: While someone may be technically most able to perform manual labor, they might much prefer to do managerial work, for example.

What really happens, of course, is that the intersection of worker preferences and technical substitution capabilities -- demand and supply -- determines whether and how workers move across jobs. For example, when states cut back on school funding, laid off teachers have moved to a wide range of jobs for which they may be overqualified and that do not necessarily reflect their preferences. Their moves are constrained by opportunities in the job market.

Welch (1972) presents an estimation technique that comes somewhat close to using the notion of the ability to substitute employees. In brief, he argues that there may be certain general skills which are combined in unique ways to create a more distinctive bundle of worker attributes which are then evaluated by the market. Using years of education as the measure of skill, he finds that virtually all of the variance in wages is explained by using only half of the possible years of education. Cotterman and Peracchi (1992) pursue this general technique and make some arguments about how to assess the benefits of additional detail in classification criteria where the goal is to explain the variance in some outcome variable like wages. What this result implies for a classification system is not entirely obvious, although it might suggest that other kinds of information as well as wages might be conveyed with relatively simple classifications of data. It is important to note that occupational classification systems are used to report labor market outcomes. That is, they are the framework to which outcomes are reported -- x wage for y job. The classification system itself does not need to explain wages or other outcomes.

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[2] The work in sociology and industrial relations on choices in production systems suggests clearly that the most important factor determining how capital is substituted for labor and, in particular, which occupations perform which tasks, is the relative bargaining power of workers, typically represented by unions, versus management. Shackett and Stevens (1981) represents one of the very few efforts to examine substitution efforts across occupations.

An important point to note about the substitution-based classification system is that it is impossible to know what it would look like a priori. The groupings would only be revealed after the fact on the basis of production function estimates. And jobs that may be substitutes for the purposes of final outcomes through a production function may not necessarily have much in common with each other.

For example, one could imagine that safety engineers might end up being substitutes for tort lawyers in certain circumstances where companies have the choice of reducing risks associated with products or facing litigation.[3] In such circumstances, lawyers and safety engineers could end up in the same occupational grouping. In this extreme case, the classification system might still reveal interesting and useful information about the similarity of these two jobs for production purposes, but the apparent dissimilarity of the jobs on other dimensions might make the system less useful. In particular, while lawyers and engineers may be substitutes for the purposes of the employer, they are not substitutes for the purposes of an employee: a lawyer could not do an engineer's job nor vice versa. Data users interested in learning about the common elements of jobs created by such occupational groupings, such as students choosing careers, displaced workers seeking retraining, or occupational counselors matching workers to jobs, would find it difficult to learn much of anything from such a grouping.

In practice, while it might seem reasonable to assume that jobs in the groupings that result would have a kind of face value similarity, one would never know in advance until the production function estimates appeared on what (if any) dimensions that similarity existed. It is not obvious that the similarities will necessarily be on dimensions like skill requirements or tasks performed. Further, the similarities may differ for each occupational grouping. As a result, there might be no apparent consistency in the overall classification system.

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[3] Lest readers think this example is far-fetched, assessing the costs of safety improvements is typically done with cost/benefit analysis which includes litigation costs and engineering modifications as two of its principal components.

A classification system that grouped jobs together based on their substitutability as generated by production function data, assuming for the moment that such a system could be generated on a reasonable basis for the economy as a whole, would not seem to meet many of the tests of a "good" classification system as discussed in the previous paper. The only information that it would reliably convey is the rather esoteric elasticity of substitution as generated by production functions. Certainly this is of interest to employers, but so is a great deal of other information about occupations that such a classification system might not reveal. For example, a variety of institutional factors such as trade union coverage could well create circumstances where occupations that were substitutes for the purposes of employers were nevertheless in very different labor markets. So groupings based on substitution would not be helpful at conveying labor market information.

Given the current state of research, we do not have elasticities of substitution for occupations that could form the basis of a classification system. Nor is it obvious at present how reasonable estimates could be generated. As argued below, however, more direct attempts at job analyses could end up doing something very similar by identifying aspects of jobs like skill requirements that translate across organizations. Such an effort might be superior even in principle to generating elasticities of substitution given that the latter are specific to particular contexts (i.e., current production systems) and may vary widely across industries and organizations.

Similarity Rather than Substitutes

At least two existing national systems of occupational classification use a criterion that appears on the surface to be something like the ability to substitute in grouping occupations. But in fact these systems rely on a principle that is conceptually distinct. Both the Canadian National Occupational Classification and the Australian Standard Classification of Occupations rely in part on employee mobility as a criterion for classifying occupations. The Canadian system uses data on actual employee mobility between jobs to construct groupings (see Roberts 1993).

Note that this is not the same as the elasticity of substitution derived from production functions. How an employer might substitute occupations for each other is not at all the same as how workers themselves might move between occupations. Nurses and doctors, for example, might be close substitutes for each other from the perspective of employers, but nurses are far more likely to become administrators than to become doctors. The Canadian system, then, is probably closer to a worker preference model than to an employer substitution model, although because it focuses on actual mobility, it really represents the intersection of the two, supply and demand.

The Australian system, in contrast, puts together occupations based on task requirements (Madden and Tam, 1993). Workers within the same occupational group would roughly be able to perform the tasks required in all jobs in that occupational grouping. This classification system does not reflect actual mobility. Rather, it suggests how workers could move based on their current knowledge, skills, and abilities. As Stevens (1993; footnote 35) points out, using potential mobility may have a series of advantages over actual mobility. Patterns of mobility may change sharply over time, creating a need for major revisions. This is especially so where current mobility patterns are shaped by institutional arrangements such as licensing requirements or patterns of union coverage which are themselves in some flux.

A simple example of the difference between a classification system based on elasticities of substitution, revealing how employers actually substitute, and one based on similarity of tasks performed might go as follows. A system based on actual substitution reflects all the current idiosyncrasies in the economy, such as licensing requirements, trade union agreements, custom and practice, etc. So a psychiatrist and a anesthesiologist might be in the same group where the classification system is based on actual substitutability because in terms of current licensing requirements the two are transferrable (i.e., the tasks in both require an M.D. degree). A system based on tasks performed might put psychiatrists and psychologists in one group, because the tasks they perform are highly similar, anesthesiologists and anesthetists in another.

Further, classifications based on actual substitutes would create groupings that reflect worker preferences. In an example used by Loewenstein and Manser (1993), school bus drivers may require skills almost identical to those of other bus drivers, but employers of school bus drivers may not be able to use other bus drivers as substitutes -- and vice versa -- because the hours of work of the former are so much more limited and idiosyncratic as to fit the preferences of relatively few drivers.

The Australian system is an example of a demand-side system that groups jobs together according to the criteria of similarity, rather than substitutability, and gets closer to the general principle in systematics that items within a grouping should have common attributes. This system identifies the attributes necessary to perform jobs and then combines occupations into groups by similarity on those dimensions. One would imagine that such groupings would put together occupations that were somewhat substitutable from the perspective of an employer, although in this case it would be a consequence of and not the criteria for grouping. Classification based on the attributes needed to perform jobs are a central feature of most job analyses, considered below.

A summary conclusion with respect to the above discussion might suggest the following. An important criterion for an occupational classification system is to create groupings within which occupations are reasonably similar from the perspective of the employer. Trying to generate such a system from elasticities of substitution is, at present, impossible from a practical perspective and might lead to a series of perverse groupings. Groupings based on similarity of tasks performed are conceptually different but might in practice give employers something very much like the same thing.

Classification Based on Employee Outcomes

But employer interests may not be the only ones that matter. Even in the Cain, Hansen, and Weisbrod (1966) model where employer concerns are dominant, employee preferences are important as factors in assessing job-employee matches. And many important aspects of employee preferences may relate to other issues. It is important to distinguish, however, between the kind of information that is generally presented along with an occupational classification system and the system itself. For example, workers are vitally interested in issue such as wages, benefits, working conditions, and other labor market outcomes. But it would be bizarre indeed to base a classification system around such outcomes.

First, labor market information is already readily available. It is attached to occupational classifications (e.g., "machinists" earn 'x' and have unemployment rate 'y'). Second, a classification system based on outcomes would be next to useless. Consider, for example, a system that grouped jobs by earnings. It would create occupational classifications such as "high wage" and "low wage" jobs. Jobs in the "high wage" category might well have nothing in common except earnings. Lawyers and plumbers might well be in the same group, for example. Information about what work was performed, what skills were required, or where the jobs stood in the system of work organization -- information usually provided in the context of an occupational classification system -- would now be lost. The classification system would convey no information other than what was already conveyed by labor market reporting. Third, the composition of the jobs in each category would change almost constantly with fluctuations in the labor market.

In terms of the principles of taxonomy, the issue of robustness discussed in the previous paper helps explain why this approach would be so peculiar. Classification based on outcomes would use a job criterion that a) is relatively hard to establish (most people cannot tell what a job pays from a simple description) b) does not covary that well with other job criteria c) changes relatively quickly. The system that is developed would then have to be used to report more qualitative criteria, like tasks performed or skills required, with which readers would be more familiar. In short, it would stand traditional classification principles on their head.

The various studies reported in commissioned papers on the Standard Occupational Classification that use different aggregations of current job titles to explain the variance in wages (in addition to those cited above, see Loewenstein and Manser 1993) were considered above. They are important and interesting as part of an effort to understand wage variance. But it is difficult to see what this approach has to say to efforts to revise the S.O.C. given no suggestion that I am aware of that explaining wage variance is among its goals.

There are, however, a series of issues that employees care about that could usefully be conveyed by an occupational classification system and that differ conceptually from what a demand-side system might report. In addition to the labor market outcomes that are already associated with jobs, the issue of most importance from the perspective of a worker is what they need to have in order to be qualified for a job. The employer in describing a job might typically be thinking of tasks that need to be performed, some of which are quite specific and perhaps even idiosyncratic. The employee, in contrast, may well be unfamiliar with these tasks and is more typically thinking of the attributes they would need to be successful in a job.

The original charge for this paper, to examine demand and supply-side approaches to an occupational classification system, comes down, I believe, to the following applications. The demand-side arguments seek to reveal information about the actual tasks that need to be performed. One by-product of grouping jobs by task characteristics is that jobs within groups tend to be similar with respect to the ability of employers to substitute across them in terms of getting work out. The substitution will not be perfect, however, as it does not reflect how employers may actually substitute across substantially different occupations. Nor will it reflect institutional restrictions or worker preferences that affect the actual ability to use different occupations. But this arrangement has the considerable advantage of grouping jobs in a way that reveals what people actually do, making it very easy for users to identify and relate to the jobs being performed. In the process, the groupings also do a reasonably good job of identifying substitution prospects.

The supply-side arguments seek a classification system that will reveal information about the worker attributes -- knowledge, skills, and abilities[4] -- that are required to do the job. This system also reveals information with which users can readily identify and relate. The problem is that it may be impossible for them to actually spot jobs in the economy in each category. Again, it will reveal something about the ability to substitute, but this time from the perspective of the employee. Careful readers will already see that the difference between these two positions may not be very great.

Research on Job Analysis

While many of these arguments from an economic perspective have wrestled with the problem of creating occupational classification systems from the perspective of an economy, there is a much more extensive literature in personnel psychology that has explored the same questions from the perspective of individual employers. Job analysis refers to systematic efforts to collect information about the work requirements of jobs. The information is then used to develop job descriptions that are the basis for recruitment and career development decisions, compensation programs, and other aspects of human resources (see Ghorpade and Atchinson 1980) for a history of job analyses). These firm-level issues are closely related to economy-level policy issues such as seeking better job-employee matches and improving skill development.

Job analyses are really classification systems for organizing jobs. They differ from national occupation classification systems in a few interesting ways. Because they suffer from fewer conflicting interests (i.e., the interest of the employer is everything) and cover a much narrower range of jobs, it is easier for them to meet the challenges of a classification system. For example, they use consistent criteria across all jobs, grouping jobs together into categories based on similarity on those criteria, and the hierarchy of categories they create reflects clear principles of causality (e.g., higher levels of criteria such as skill requirements as well as promotion and career ladders). One of the difficulties that many academics have in considering a national system of occupational classification is that such a system cannot reasonably meet the standards of typical job analyses on matters like parsimony and consistency.

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[4] It is an interesting question as to whether other attributes, such as preferences, that do not relate to job performance should be included in this list. It may be difficult to identify what really counts as a preference. If something affects my ability to do a job -- I prefer customer contact because I am good with people -- is that really a preference or is it simply that I want to do things at which I am good?

Job analysis systems fall into two groups that overlap neatly with the demand and supply distinction noted earlier. While both systems look at the job and what it requires, they look at it from two different directions. Task-based analyses, from the demand side, focus on identifying the actual tasks that need to be performed and the behaviors required by the job. Most job analyses are task-based, and their design is reasonably straight-forward. One way to think of this approach is to imagine that you were an employer who was describing what they literally wanted to see an employee doing in a particular job. Trait-based analyses, from the supply side, looks at what individual workers need to have with respect to knowledge, skills, and abilities in order to perform a given job. Examples of some of the better-known trait-based systems are described below. The task and traits tend to blur a bit in practice:

- ***The Position Analysis Questionnaire (PAQ)*** has been the most thoroughly researched and academically prominent of the job analysis methods (see McCormick and Jeanneret, 1988).[5] The theme of the PAQ is to identify the basic behaviors and aptitudes required of jobs. There are 187 items in the questionnaire which can be divided into six general categories: Information (where and how one gets information needed for the job), mental processes (reasoning, decision making, etc.), work output (physical activities, tools, etc.), relationships with others (measures of complexity), job context (social and physical context of work), and a catch-all "other" category. While the PAQ's focus on work behaviors, as opposed to tasks, has sometimes been criticized in the context of differentiating jobs, it is an advantage in helping to identify what workers need to know across a broad range of jobs that require similar kinds of behavior. The ability of the PAQ to identify basic work KSA's has been examined with a series of tests of the relationship between PAQ job scores and performance of job incumbents on the General Aptitude Test Battery (GATB), perhaps the most widely used test of employment aptitudes. People gravitate toward jobs that use their skills, and these studies correlated GATB scores of incumbents with PAQ scores for their jobs. McCormick and Jeanneret (1988, p.831) summarize the results which are strong.[6] Also, studies within individual firms using commercial tests of intelligence, verbal aptitude, numerical, spacial, and clerical aptitude show reasonably good correlations with the PAQ, around .70. What these tests show is that PAQ measures of job requirements track the characteristics that workers in those jobs actually have. This is not the same as establishing validity -- identifying "true" requirements of jobs -- but these results are consistent with a valid measure under the assumption that workers sort themselves out by job according to KSA's.

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[5] There is also a Professional and Managerial Position Questionnaire (PMPQ) which is very similar.

[6] The assumption is that on average, current incumbents in jobs have exactly the KSA's necessary to do their jobs -- no overqualified or underqualified workers. This may be a reasonable assumption as long as the job analysis is based on a large number of incumbents. At the very least, the match between KSA's and requirements cannot vary across jobs.

- ***The Management Position Description Questionnaire*** was developed by Control Data Business Advisors for use with their own managerial employees but has become popular in many white collar organizations, in part because its focus on managerial jobs made it appear more applicable to them (see Page, 1988). The basic categories of this method of job analysis are presented in Appendix A, but the KSA's can be categorized as follows: leadership skills (motivation, coaching), administrative skills (planning, allocating), interpersonal skills (conflict management, group process skills), communications, decision making (information management, analytic ability), and professional knowledge (company-specific practices, technical skills such as accounting).

- ***The Threshold Traits Analysis System*** is a different approach that focuses explicitly on individual job holders, rather than on the jobs themselves, and examines the traits that they possess (Lopez 1988). Those traits can be broken down into ability factors, which are subdivided into aptitudes for acquiring knowledge or skill and proficiencies for skills already possessed; and attitudinal factors, which affect the willingness to perform at given levels. The specific traits include physical traits such as strength, mental traits such as problem-solving and memory, learned knowledge and skills such as communication, motivation and adaptability, and social traits such as influence and cooperation.

- ***Ability Requirement Scales.*** These scales attempt to identify generic abilities and are based on 50 item categories. Perhaps more than the other job analysis systems described here, the Ability Requirements Scales focus on physical and perceptual factors. Among the nonphysical categories, communication skills, reasoning, and problem solving feature heavily (see Fleishman and Mumford, 1988).

- ***Functional Job Analysis*** was developed out of the need to determine worker characteristics required for the jobs described in the *Dictionary of Occupational Titles*. This method is designed to be straightforward, and there are far fewer decisions for job analysts to make than in most methods. The Functional Job Analysis scales fall into seven categories: Data functions (complexity in the use of information), people functions (level of interpersonal skills demanded), functions using things (physical requirements, typically with machines), worker instructions (level of responsibility), reasoning development (from common sense to abstract undertakings), mathematical development (math skills), and writing functions (see Fine 1988).

Assessing the Merits of Task and Trait-Based Systems

It might be reasonable to think that when two different systems designed to serve the same purpose co-exist for a long period of time, their differences probably are functional for the users in some way. That is, they probably produce slightly different outcomes and that users can choose which one they want based on the outcome they want.[7] Taber and Peters (1991) and

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[7] See Schmitt et al. (1993) for a detailed overall survey of job analysis-content validity issues.

Cellar, Curtis, and Kohlepp (1989) find that different job analysis systems can lead to different results. Levine et al. (1980; 1983) also compare a range of job analysis methods, including both task and trait-based systems. Again, the results vary, depending on the context, although the method most preferred by practitioners was a task-based approach.[8]

It might seem that task-based systems are somewhat simpler for the following reason. Trait-based systems more or less have to start with some understanding of the tasks required by the job in order to identify what it requires from workers. So a trait-based system might only be as good as the task analysis with which it begins.

When tasks are straight-forward and easily defined, there appears to be very little difference between task and trait-based systems. Consider a simple manual job where the incumbents lift products off a line and pack them into boxes. The task analysis says something like "lift heavy objects, pack neatly into boxes, work quickly and diligently for long periods without a break." The trait-based analysis of the same job would say something like "the physical strength needed for heavy lifting, endurance and stamina, some spatial acuity and diligence."

Where tasks are not straight-forward, however, trait-based systems seem to have an edge. The previous paper described changes in work systems where many jobs were now broader (encompassing more tasks) and incorporated some supervisory tasks. Not only are many more tasks required, but the tasks may vary considerably over time. A task-based system that listed everything one might be required to do in such jobs could be prohibitive; a system that tried to predict the "most common" tasks might well be defeated by a truly flexible arrangement for work organization.

Further, task-based systems have a difficult time identifying what is needed in jobs that are entry-level but where the incumbents are expected to move on to higher-skilled positions. Consider, for example, the tasks required of a "trainee" or "apprentice." An applicant may be fully qualified for those positions, based on a task-based job analysis of them, and yet not have the basic abilities needed for the ultimate craftsman job.

Finally, task-based systems have perhaps the most difficulty in addressing jobs where creativity and ingenuity are required as it is difficult to describe the tasks needed to achieve outcomes that cannot yet be articulated. Consider, for example, computer programmers who are asked to design new software. One could describe the tasks that were involved in designing previous software, but there is no reason to think that they will be the same ones needed to solve emerging problems.

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[8] Job evaluation systems, which compare job content across jobs quantitatively, seem to show surprisingly high consistency in their results, however. Snelgar (1983) and Gomez-Meija et al. (1982) find that there is a high level of agreement across the different systems currently in use.

In all of the above examples, trait-based job analysis systems seem to have clear advantages. But there are also some difficulties inherent in trait-based systems, in addition to the basic problem noted above of that it is difficult to use them to identify real jobs in the economy. First, such arrangements might have a very difficult time handling the context issues that are central to differentiating occupations, leading to situations where trait-based analyses do not adequately differentiate occupations. For example, many of the skills and abilities required for surgeons might look very much like those of machinists (e.g., considerable dexterity with cutting tools, working with extraordinary precision, etc.). On the other hand, trait-based analyses of surgeons and psychiatrists might look so different that it would be difficult to recognize their commonality as doctors.

Another practical problem with trait-based job analyses in the U.S. context concerns protective labor legislation. Specifically, the statutes and case law on issues like discrimination turn very explicitly on task-based definitions. The Americans with Disabilities Act (ADA) in particular is especially task-based (see Gottfredson 1994 for a good exposition on these issues). Shaw (1990), for example, finds that employers were more successful in defending against discrimination cases where job analyses were behavior-based rather than trait-based.[9]

Conclusions and Recommendations

While there is an intuitive appeal to having a classification system that is simple and driven by a single criterion, research on systematics in other fields suggest that such approaches do not produce useful classification systems. Simple systems are not robust, and they also impose severe costs on the interests of diverse users -- being "perfect" for one set of users but basically unworkable for others.

The same conclusion seems to hold here. It seems necessary to have some aspects of demand-based, or more accurately a task-based criterion, simply to identify real jobs in the economy. A classification system is not very useful if users cannot associate actual jobs with it, and users at this point in time think about jobs based largely on the tasks that are performed. Further, many arguments about the importance of worker interests and the way that jobs may be changing in the economy suggest that greater importance be given to supply or trait-based criteria.

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[9] Harvey (1994) makes the interesting point that the ability to rate jobs -- either on task-based or trait-based systems -- has been far outstripped by our development of scales on which to rate them.

Perhaps the most important conclusion from the more practical research on job analysis is that task and trait-based systems may not be very different, at least for tasks that are straight-forward. Much of the general concern about trade-offs in benefits between different classification systems may therefore be misplaced.

Finally, it is important to note that task and trait-based criteria do not completely address all of the interests in occupational classification systems. At least some work context criteria are needed to get at other issues. Perhaps the most obvious of these for many workers (and for researchers as well) is to learn about promotion opportunities. A classification system that reflects something about actual job hierarchies, that grouped jobs based on career progressions, would help convey that information.

A system based on task, trait, and context criteria sounds complicated; but, compared to classification systems in other fields, it is reasonably straight-forward. Some combination of task, trait, and context criteria in developing occupational classifications may actually do a better job of delivering on the kind of promises made for the substitution criterion than would a system based on elasticities of substitution. And it would also be able to deliver a great deal more information for other users.

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FRAMEWORK FOR A REVISED STANDARD OCCUPATIONAL CLASSIFICATION (SOC)[1,2]

J. W. Cunningham
North Carolina State University

Donald W. Drewes
North Carolina State University/Conserva, Inc.

Thomas E. Powell
North Carolina State University/Monterey Technologies, Inc.

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[1] The first two authors contributed equally to this paper.

[2] The authors accept all responsibility for the accuracy of the contents of the paper, and for all opinions that are expressed. There should be no presumption that these views are shared by anyone affiliated with the sponsoring agency, the Department of Labor.

EXECUTIVE SUMMARY

I. ORIENTATION

The Standard Occupational Classification (SOC), first published in 1977 and updated in 1980, is scheduled for a major revision in 1997. The Bureau of Labor Statistics (BLS) has been assigned lead agency responsibility for the initiation and coordination of a comprehensive revision effort. BLS in concert with the Employment and Training Administration (ETA) has initiated a series of activities designed to produce a revised SOC for use in the forthcoming decennial census. Early activities included the commissioning of a series of papers presented at the International Occupational Classification Conference sponsored by BLS and held June 22-24, 1993, at Washington, DC. The papers, discussion comments, panelists' remarks and audience input were subsequently published as conference proceedings. As a follow-up to these efforts, the SOC Revision Policy Committee has commissioned six papers to address the issues and options of SOC revision in greater detail. This paper is one of the commissioned works.

The general purpose of this paper is to explore the issues and options associated with the development of a skills-oriented SOC. More specifically, this paper seeks to identify, organize and elaborate upon the conceptual and methodological issues associated with the development of a skills-oriented SOC; to develop methodological options for resolving identified issues; and to suggest a recommended framework for SOC revision. It is intended that the proposed procedures be sufficiently detailed so as to provide a general methodological framework, yet retain adequate flexibility to accommodate subsequent technological and administrative contingencies.

The paper is organized according to six chapters. Chapter II will be devoted to an identification and analysis of the major issues underlying the development of a skills-oriented SOC. Issues will be distilled from a synthesis of the major literature with direct relevance for SOC revision. Chapter III will present classification principles derived from the issue analysis and intended to support subsequent procedural recommendations. Chapter IV will be devoted to a discussion of conceptual and methodological approaches to framework development. Chapter V presents a general strategy for the SOC revision. Chapter VI will conclude with a meta vision as to how a revised SOC and a reinvented DOT might be integrated into a unified occupational database.

II. ISSUE IDENTIFICATION AND ANALYSES

Before proceeding, a definition of issue is in order. As used in this paper, the concept of issue implies a choice. Issueness arises when there is not clear-cut agreement on the values accruing to differential choices. Uncertainties frequently exist as to the technical and political feasibility of decision options as well as the expected consequences of choosing specific options. In recognition of the underlying uncertainty, issues will be phrased as "can" and "should" questions. Can-oriented questions reflect an uncertainty as to the likelihood that a state of affairs is physically achievable. Should-oriented questions reflect an underlying uncertainty as to the wisdom of obtaining a particular state of affairs. In this paper, both can and should questions will be used to frame issues.

Issues to be subsequently discussed were identified based upon a screening of secondary data sources. A principal source was the Proceedings of the International Occupational Classification Conference (1993), hereafter referred to as Proceedings. Papers, comments and remarks presented in the Proceedings were supplemented by a review of the occupational cluster papers prepared in conjunction with DOL's skill standards initiative. Further information was derived from an examination of SOC-related documentation and a review of the professional literature having special relevance for occupational classification.

Based upon an examination of the above sources, candidate issues were identified. Issues were sorted, combined so as to reduce overlap and redundancy and edited to sharpen clarity and focus. The final issues so identified were grouped by content similarity into four major classes. The first deals with the major purposes/usages of a revised SOC. The second discusses issues associated with the introduction of skill as a classification principle. The third relates to classification-related issues, and the fourth with issues pertaining to linkage of the SOC with other systems. Issues assigned to each of the above classes will be individually discussed.

SOC Purposes/Uses

What Should Be the Principal Purpose of a Revised SOC?

Summative Conclusion. Occupational classification and coding are the twin functions that must be supported by a revised SOC. The need for crosswalking was one of expediency due to the lack of a truly standardized occupational classification system. To the extent that occupational classification systems serve idiosyncratic agency needs, crosswalking will continue to be a necessary auxiliary function. Conversely, to the extent that a *standardized* system emerges, the demand for crosswalking capabilities will fade as alternative systems merge into a single entity.

Should a Revised SOC Attempt to Balance Counting Accuracy With Descriptive Detail?

Summative Conclusion. The SOC is a necessary component in the design, development and use of an occupational information database. The SOC performs an integrative function by providing the definitional uniformity and the occupational structure necessary for the identification, collection and presentation of supportive occupational descriptive detail. Thus, the SOC provides the taxonomic structure and definitional detail that when supplemented with auxiliary data organized by taxonomic levels will constitute an occupational database. Although an integral part of an occupational database, the revised SOC should be designed to have stand-alone capability. Major occupational data producers such as BLS and Bureau of the Census need direct access unencumbered by unnecessary descriptive detail. Consumers of occupational information, on the other hand, find that auxiliary detail is essential to their intended purposes. The necessary balance between counting accuracy and descriptive detail will be dependent upon the extent of coordination and cooperation between agencies responsible for SOC revision and those responsible for the development of a supportive descriptive database. Recommendations for the development of an integrated SOC-DOT system will be presented in Chapter VI.

Can or Should a Revised SOC be Useful for Both Household and Establishment Survey Sources?

Summative Conclusion. The issue apparently seems to involve a mixture of technical considerations and agency preferences. Coding problems with household surveys can be resolved by one of two basic ways: code at the level of occupational detail permitted by the survey at the risk of sacrificing detail at the unit level or modify the survey so as to collect additional occupational detail. Modification of survey forms might include inclusion of contingency questions designed to collect more occupationally specific data perhaps modeled in some respects after the checklist forms used by Ohio (Sommers, 1994). Enforced adherence to a revised SOC would seem to curtail current agency tendencies to solve technical problems by deviating from SOC standards.

Skills-related Considerations

Should the Revised SOC be Based on Skills or on Work Performed?

Summative Conclusion. From an economic and social perspective, the structuring of work performed is a basic societal function. The fundamental nature of work performed has been historically recognized by occupational analysis. In fact, it was the near total focus on work activities that caused psychologists like E.J. McCormick to champion a more worker-oriented approach. As a result, work activity and worker attributes are today considered as the twin domains of the world of work.

With due recognition of this duality, we propose that work performed be the classification basis for a revised SOC. We do this for three separate but related reasons. First, work activities are the fundamental units of our economic system. Second, work activities are more readily definable than worker attributes. Lastly, worker attributes can always be inferred from work activities.

Is There an Inherent Advantage in Classifying Occupations by Skills Level and Skills Type (Content)?

Summative Conclusion. Classification of occupations by skill level and type appears to have considerable merit. Occupation has long been regarded as a major determiner of socio-economic status (SES). Changing world market conditions are mandating that America's workforce be developed to meet changing workplace requirements. The task is not as formidable as it might first seem. As Wootton (1994) correctly concludes, " 'skill-based' occupational classification structures are not so different from those based on "work performed" (p. 332). International experience has demonstrated the feasibility of developing a skill level by type classification system. It but remains for the United States to apply its ingenuity to the development of a skill level by type classification system tailored to the nation's unique needs.

Is Required Educational Level an Adequate Indicator of Skill Level?

Summative Conclusion. While the potential utility of skill level in an occupational classification system is generally acknowledged, no such agreement exists for its measurement. Considerable apprehension has been expressed concerning the capability of educational attainment to capture the nuances implied by skill level. A suggested approach is to abandon the mono-operationalism and to employ multiple factors as definitional indicators. An intriguing possibility is to extend the concept of job evaluation to apply to occupations. Just as jobs are assigned pay levels, it should be possible to assign occupations to skill level using **specially selected leveling variables**. Leveling variables are occupational descriptors which on the basis of a priori experience are known to differentiate occupations. Examples might be measures of cognitive complexity, creativity, resource control, wages and educational requirement level. The important consideration is that skill level would be operationalized by a triangulation of multiple indicator variables. A further elaboration of this concept will be provided in Chapter V.

What Role Should Wages Play in the Determination of Skill Level?

Summative Conclusion. That mean wages differ by occupational category even when typical human capital variables have been partialed out argues for the inclusion of wages in any function designed to allocate occupation to a skill level. The major problem with wage data is not conceptual but rather one of general availability. BLS has recently initiated the OES wage survey design to collect estimates of numbers of people employed by wage range and estimates of median and mean wage rates for OES occupations. Currently, fourteen states are participating in the initiative (McElroy, 1994). Wage data are reportedly being collected at the three-digit OES level. Whether wage data collected at this level of aggregation will be useful for the classification of occupations by wage level is highly problematic. The information available at this time suggests that while the inclusion of wages is based on a sound rationale, the practical utility of their inclusion remains to be determined.

How Should Skills Transferability Across Occupations be Operationalized?

Summative Conclusion. Use of retraining time as a proxy for skills transferability has considerable intuitive appeal. Retraining time is a unitary construct that is readily scaleable. The same scale can be used to assess transferability between any pair of occupations, thereby providing a common metric across applications. Retraining time parallels in intent the Specific Vocational Preparation (SVP) scales used in the DOT. The utility of the SVP scales as expressed by frequency of citation in the Proceedings lends credence to the proposed use of a retraining scale for the operationalization of the extent of skills transferability. The critical distinction to note is that retraining time measures the extent of skills transferability as opposed to identification of the skills being transferred. Resolution of that issue is the subject of the next section.

Classification-related Issues

Should Occupational Grouping be Directed by Demand- or Supply-side Concepts?

Summative Conclusion. The role of demand- and supply-side concepts in occupational classifications hinges on whether work- or worker-centered variables are the more useful for classification purposes. We contend that demand-side concepts couched as work activity requirements are the more meaningful sorting variables for SOC revision. Demand is more sensitive to changes in the production function than is supply. Supply as the stock of qualify human capital frequently lags demand due to market imperfections. To base an occupational classification system on the collective results of individual career decisions would make an occupational classification system captive to institutionalized restraints, thereby reducing its sensitivity to changing workplace requirements.

What Sorting Variables Should be Used to Define and Aggregate Occupations?

Summative Conclusion. Sorting variables for a revised SOC should include a carefully selected set of work activities defined at differential specificity levels. Depending upon the generality level of the occupational groupings desired, work activity sorters can be selected so as to produce occupational clusters at the desired specificity/generality level. Conceptualization of work activities according to successively higher levels of generality has a decided classificatory advantage. As the generality level of occupational groupings increases, the likelihood of technological obsolescence decreases. McCage (1994) offers the substantiating observation that "Contrary to popular belief, the tasks that workers actually perform do not change that much over time if they are properly identified and verified to start with.. What does change are the materials and technologies that the drive the processes, not the tasks that are performed" (p. 14). At successively higher levels of generality, the effects of technological change should tend to dampen out.

How Should a Revised SOC Unit Group be Defined?

Summative Conclusion. Consistent with the considerable interest in integration of the revised SOC and the reinvented DOT, DOT occupational descriptions appear to be the most logical candidates for occupations. Although subject to some limitations, the DOT is the most comprehensive occupational information database currently available at the national level. Crosswalks exist linking DOT occupations to both the SOC and the OES. Unfortunately, OES-

DOT crosswalks do not exist for the latest OES version.

Rather than use individual DOT occupations as unit groups, we recommend instead that clusters of DOT occupations constitute a unit grouping. There is considerable support for the formulation of unit clusters based on the principle of intra-cluster substitutability. The underlying principle is that there should be more substitutability within a cluster than between clusters. Cain, Hansen and Weisbrod (1967) stipulated that in order for an occupational classification system to be useful for economic purposes, "occupational classes should therefore be relatively homogeneous, in the sense that a high degree of substitutability should exist within each class" (p. 49-50). Use of substitutability as an indicator of occupational homogeneity has been affirmed by several Proceedings authors (Popkin, 1994; Loewenstein & Manser, 1994; Bakker, 1994).

Consequently, we recommend that DOT clusters be formulated on the basis of intra-cluster substitutability. Simultaneous clustering of all 12,000 plus DOTs would be a gargantuan endeavor with remote chance of success given current resource limitations. Therefore, we further recommend that DOT occupations be grouped a priori according to content similarity and that unit clusters be derived from a restrictive set of DOT occupations. Two options are immediately available: use the 1980 SOC-DOT crosswalks or the OES-DOT crosswalks. Either choice results in a more manageable number of DOTs that share similar content by virtue of their common membership in a parent SOC or OES grouping. Subclustering within a parent SOC or OES grouping on the basis of substitutability serves as a further screen to ensure intra-cluster similarity with resulting economic information on labor resource flexibility.

Is Retraining Time an Acceptable Proxy for Skills Substitutability?

Summative Conclusion. As a resolution of this classification issue, we contend estimated retraining time is a viable proxy for skills substitutability and should be used to define the unit occupational groups in a revised SOC. Unit groupings could be formulated by clustering DOTs nested within current occupational classifications for which comprehensive and reliable crosswalks exist. Candidate classifications systems are the 1980 SOC and the OES. By clustering according to estimated retraining times, unit groupings could be formulated that reflect homogeneity with regard to intra-cluster skills substitutability. In the clustering process, DOTs that did not seem to belong to the initial parent grouping could be identified and reclassified. The use of unit occupational groupings to create a revised SOC will be described in greater detail in Chapter V.

Linkage to Other Systems

Should any Future Version of the DOT be Assembled at the SOC Level?

Summative Conclusion. A major issue is not whether the SOC and DOT should be integrated, but rather how this integration may take place. Definition of unit groupings in a revised SOC as clusters of DOT occupations homogeneous with respect to retraining time operationalizes the enfolding of the two systems. In this manner, integration occurs at the most fundamental level of the occupational classification taxonomy.

The intermeshing of the two systems should not be confined to the unit groupings but should occur at all taxonomic levels. DOT Content Model occupational information should be graduated by level of generality to correspond with the taxonomic level at which it is provided. Minor group occupational information should be more general than unit group information, and the generality level should increase from minor to major to divisional levels. Graduation of occupational informational detail raises questions as to what is meant by level of detail. For quantitative data, leveling can be accomplished by simple summations or averaging. For most of the qualitative occupational information, composite rather than aggregate data will have to be provided. Given this approach, SOC-DOT integration will be accomplished at all taxonomic levels. This approach differs from that advocated by Stevens in that differentially detailed supplementary information is provided at all levels rather than only for tier one occupations as he proposed (Stevens, 1994). Decisions as to the scope of Content Model information to be provided at each taxonomic level and the criteria to guide taxonomic leveling of supplemental occupational information remain to be resolved during the developmental stage. Additional framework details will be provided in Chapter VI.

III. CLASSIFICATION PRINCIPLES

This chapter presents the principles of classification that guide our proposed framework for SOC revision as described in subsequent chapters. These principles are similar in intent to the twelve classification principles of the 1980 SOC. They serve to convey the underlying rationale of framework development, communicate the purpose and intent, and differentiate the broad areas of framework coverage. These principles differ from those of the 1980 SOC in that they address structural rather than substantive classification concerns. The fundamental differences are derived from the distinction between the rational and empirical approach to classification design. Each principle is stated as a design imperative. Principles are intentionally stated in a broad context so as to underscore their macro-influence upon subsequent framework design considerations.

The Classification Should be Based on Work Activity Requirements

Work activity requirements are succinct statements generally consisting of an action verb and an object acted upon. These activity statements are descriptive of work required in the production of goods and services. In the sense that they denote production function requirement, work activities are considered to be demand based. The important consideration to note is that these statements pertain to work required to be accomplished as distinguished from the acquired characteristics of people viewed from a supply-side perspective.

Work activity requirements should be sufficiently comprehensive so as to be descriptively applicable to all work performed in the civilian sector of the U.S. economy. The implication intended is that all work should be potentially describable by a manageable number of appropriately crafted work activity statements. Description of the work domain with a carefully chosen set of activity descriptors is to be conceptually differentiated from a dictionary approach to work with its myriad of situational and contextually specific details.

Work activity requirements should be developed to span the occupational specificity-generality continuum. Work activity requirements should range from those descriptive of the specific unit occupational groupings through intermediate and general levels and finally to the more foundational work activities that cross broad occupational content groupings. The important consideration is that work activities can be defined at higher levels of generality with implications for broader levels of classification granularity.

The Classification Should be Structured According to Skill Level and Skill Specialization

Unit occupational groupings should be arrayed into a matrix structure, where skill levels are the rows and skill specialization the columns. To create this matrix arrangement, unit occupational groupings should be identified and clustered into twenty to thirty major content groupings according to similarities of work activity requirements. These major groupings would represent a first approximation to the divisional structure of a revised SOC. This prototypic divisional structure should be evaluated and revised as necessary to create a meaningful divisional classification.

Once these major divisional groupings have been established, the member unit groupings of each divisional cluster could be assigned to a specific skill level. This assignment could be construed as the occupational analogue to job evaluation. Occupational groupings could be assessed according to factor scores and the assignment made to skill levels using decision models that would minimize classification error. In this manner, a skill level by content specialization matrix could be induced. Cells in the resulting matrix would contain unit occupational groups in a specific division and skill level. These cells could operationally be defined as constituting the major groupings of the revised SOC. Further differentiation within nonempty matrix cells would produce the minor groupings of the proposed classification structure. By this procedure, all unit, minor and major groupings would be assigned a unique skill level.

The Classification Should be Created by Numerical Taxonomic Methods

The classification structure for the revised SOC should be created using numerical taxonomic methods. Occupational unit groupings should be clustered in a bottoms-up manner according to similarities of work activity requirements. Unit groupings should be clustered to form minor groupings and minor groupings merged at a higher level to create major unit groupings. In order to create the skill level by content matrix, a two-stage cluster procedure is envisioned. In the first stage of the numerical clustering, unit occupational groups would be clustered into major technological content divisions. To sharpen the differentiation within divisional classifications, division-specific work activities would be introduced and used in the second-stage clustering. Unit occupational groupings would be evaluated and assigned to skill levels. Within each skill level and division, a second-stage clustering would be performed to establish the minor groupings.

Numeric taxonomic methods should be utilized so as to allow inclusion of a sufficient number of work activity requirements required to make meaningful content differentiations. Three to five hundred work activity requirements are anticipated to be required to produce a meaningful cluster structure. This number of sorter variables, while well within modern computing limitations, exceeds the capability of the human mind to deal with in a rational manner. Human judgment is best utilized in an evaluative modality to assess the meaningfulness of the numerically derived cluster structure and to make such adjustments as are necessary to improve cluster interpretation.

The Classification Should be Hierarchical With Unit Occupational Groupings Defined as Clusters of DOT Occupations Homogeneous With Respect to Activity Requirements Substitutability

The classification should be hierarchical with unit occupational groupings as the most fundamental classification unit. Unit groupings should be clustered according to similarity of work activity requirements. Resultant second-level clusters would correspond to minor groupings which would be subsumed under major groupings. Major groupings would, in turn, be subsumed under divisional groups.

Although the system structure would be hierarchical, the proposed clustering procedure is not strictly hierarchical. What is proposed is a two-stage clustering procedure, where the first clustering is used to identify divisional groupings. Occupational unit groupings would then be leveled by skill categories, thereby creating a skill-by-content matrix with divisions constituting the columns and skill levels the rows. Second-stage clustering would be applied to each cell in the skill level by content matrix to create minor groupings, major groupings having already been achieved by the assignment of unit groupings to skill classes.

Unit groupings should be a priori constituted as clusters of DOT occupations with high intra-cluster substitutability. Skill substitutability should be operationalized as retraining time and unit clusters formulated on the criterion of less retraining within than between clusters. Once unit occupational groupings have been formed, these clusters would then constitute the building blocks of a revised SOC. In this manner, SOC-DOT integration would be achieved at the lowest classification level. Moreover, DOT 9-digit occupations would be retained under the unit groupings, thereby providing a crosswalk from the 4th edition DOT to the revised SOC.

The Classification Should be Used to Structure the Collection, Presentation and Dissemination of Occupational Data in a Reinvented DOT

The classification should provide the structural integrity for a reinvented DOT occupational database. The implication is that DOT descriptive occupational data should be organized and presented in accordance with the SOC structural categorizations. Occupational data as generally described by the APDOT Content Model should be provided for all unit occupational groupings. Consistent with this principle, selected occupational data should be presented at each subsequent level of the classification hierarchy, i.e., minor group, major group and division. Presentation of occupational data at subsequently higher levels of generality will require that occupational data be defined at correspondingly increasing levels of generality. For qualitative occupational data, this will require the synthesis of data at lower levels into composites suitable for higher levels. Quantitative data can be aggregated and measures of central tendency and variability used at higher generality levels. Used in this manner, a symbiotic SOC-DOT bond could be created. The SOC would provide the organizational structure and the DOT the content substance. United they would create the occupational database for the twenty-first century.

The Classification Should be Directly Linkable to Private Sector Skills Standardization and Certification Efforts

The revised SOC should play a coordinative and integrative role in the ongoing skill standardization and certification initiatives. The classification should provide the definitional and structural framework for skill standards determination. Classification should be so designed as to be readily linkable with the private sector at the firm level. Integration of public and private classification efforts would be a major milestone toward the development of a world class workforce.

IV. CONCEPTUAL AND METHODOLOGICAL APPROACHES

We shall propose that work-related human characteristics and occupational characteristics are simply two sides of the same coin, supply and demand, and that both can be defined in terms of activity descriptions.

Worker Characteristics

Conceptually, human capabilities are defined as relatively stable internal states (potentials) of the organism that enable the individual to carry out tasks. Operationally, capabilities are defined in terms of the individual's levels of performance on specified classes of tasks. The tasks can be contained in tests, work samples, jobs, etc.

The term knowledge usually refers to some specified "body of understood information possessed by an individual..." that he/she can recall under appropriate circumstances; "more complex knowledge is called `comprehension' or `understanding' (which includes awareness of relations, meanings, etc.)" (English & English, 1958, p. 284). The term skill is more difficult to define, because it has acquired more than one meaning. For our purposes, however, "skill" is defined as a developed proficiency or competence to perform a specified class of tasks, either physical or mental (e.g., typing, driving, writing, drafting, bargaining, etc.). Operationally, "knowledge" can be defined in terms of information content and "skill" in terms of specified activities. In exercising a complex skill, the individual draws on knowledge as well as other attributes. In this paper, we shall not differentiate between "knowledge" and "skill," because in occupational analysis the two are usually confounded in work activity statements.

Consistent with the APDOT model, several human capability definitions are offered marking different levels in a developmental hierarchy starting with the basic and general and progressing to the more numerous, content specific, and complex. These include: Sensory Capacities; Physical and Sensorimotor Capabilities; Basic Mental Abilities; Basic Skills; Cross-Functional Skills; and Occupational Knowledges and Skills (KSs), subsuming from the more general to specific respectively General Occupational KSs, Cluster KSs, and Occupation-Specific KSs. Other personal qualities--such as work-related interests and needs, values, self-esteem, and personality traits--can also be operationally defined in terms concrete activities and conditions. For example, interests could be viewed as preferences for (tendencies to approach or avoid) specified classes of work activities, and work-related needs as preferences for more general classes of work benefits, opportunities, outcomes, conditions, etc.

Occupational Characteristics

The preceding constructs define what people supply to the workplace. Job and occupational characteristics, on the other hand, represent what the workplace demands of people, its human requirements. Although conceptually worker characteristics are inferred internal states of the organism, operationally they can be described in terms of concrete behaviors or activities. Correspondingly, we propose that occupational requirements be characterized in terms of worker activities rather than worker attributes. Compared to human attribute definitions, work activity statements are less abstract, easier to understand and envision, and require less inference when used as job or occupational descriptors.

The defined activity components in jobs/occupations include, from specific to general: Tasks, Duties, and Generalized Work Activities (GWAs). Tasks and duties are deemed too specific to serve as vehicles in forming an occupational classification system, leaving GWAs as the most viable alternative. The GWAs themselves span a range on a specificity-generality continuum, which we have subdivided into the following narrower categories: (a) Area Work Activities (AWAs), which are technologically oriented and limited to particular content areas (e.g., Health Care); (b) Intermediate Work Activities (IWAs) which, like the AWAs are job-oriented, but apply to wider content ranges; and (c) Foundation Work Activities (FWAs), which are more worker-oriented and apply to the broad spectrum of occupations. Although the analogy is not precise, AWAs correspond roughly to the previously defined Cluster KSs; IWAs, to General Occupational KSs; and FWAs, to the more basic and general (foundation) capabilities, ranging in the hierarchy from Sensory and Sensorimotor abilities to Cross-Functional Skills.

Positions are defined as collections of tasks/duties constituting the total work assignments of individual workers, and jobs as groups of similar positions within single business establishments or other organizations. Occupations are defined as similar jobs across establishments or organizations. Jobs are the basic units analyzed by the U. S. Employment Service in compiling Job Analysis Reports which, in turn, are merged into the occupational descriptions appearing in the Dictionary of Occupational Titles (DOT). Occupations are the basic taxonomic units in the current DOT. Finally, occupational clusters are defined as groups of occupations with similar human requirements. The nature of an occupational cluster depends upon the nature and scope of the common requirements on which it is based. Because we propose to define occupational characteristics in terms of activity statements rather than human attribute definitions, we shall define an occupational cluster as a group of occupations with similar requirements as represented by the previously defined GWAs (i.e., AWAs, IWAs, and/or FWAs).

Approaches to Occupational Grouping

To date, virtually all occupational classification systems have been rationally derived. More recently, however, there has been increased interest in numerical grouping through application of computerized clustering algorithms to jobs' and occupations' profiles on descriptors such as those previously described. The latter efforts have been encouraged by the development of structured job analysis procedures and the increased capability and accessibility of computers and software packages.

Rationally Developed Occupational Groupings

The process by which occupational groupings are rationally derived may be relatively explicit or implicit in terms of the underlying conceptual framework, and structured or unstructured in terms of procedures. An explicit approach would involve the derivation of occupational categories from an explicit theory or from a set of predetermined classification dimensions or categories such as those in the BLS Prototype Job Family Matrix. A completely implicit approach would involve judgmentally grouping occupations on a global, inductive basis and then attaching labels to the resultant groups. In practice, most of the established occupational classification systems reflect combinations of both approaches in varying degrees, where broad defined frameworks were used to focus more implicit judgmental efforts. Most established systems were also developed through a relatively unstructured process, with individual participants determining their own strategies for defining categories and groups. Under a structured process, on the other hand, participants would generate ideas and make judgments according to a defined set of rules and procedures. A structured process can enhance the rational approach.

Classification systems based on the rational approach have the advantages of being relatively economical to develop, comprehensive in scope, and intuitively meaningful. Some potential disadvantages are that (a) the processes through which such systems are derived do not always explicitly identify salient underlying variables to tell us why an occupation belongs to a particular group; (b) different individuals will likely consider different variables (or weight the same variables differently) in forming groups or assigning occupations to them; (c) compared to the numerical alternative described below, the rational process may not take as many variables into account in forming the categories or groups; and (d) the salient variables that are identified may not be sufficiently numerous, defined, and measured to support subsequent electronic assignment of jobs/occupations within the completed system.

Numerically Derived Occupational Groupings

Under numerical classification or taxonomy, jobs or occupations are assigned numerical values on a set of descriptors, and the resultant descriptor profiles are used as a basis for clustering. The kinds of descriptors used in numerical job and occupational clustering have included many of the previously defined worker and occupational characteristics. In this paper, we propose to use GWAs as the profile variables for occupational clustering.

Although the field of numerical job/occupational taxonomy is relatively new, there is a cumulative body of evidence supporting its viability. The numerical approach offers the advantages of (a) explanation through explicit identification of the salient variables on which clusters are based; (b) the capability to involve a large set of accountable variables in the clustering decision and control their relative weighting; (c) electronic assignment capability; and (d) as a side benefit from descriptors such as IWAs and FWAs, the capability to estimate jobs' human attribute requirements through the job-component approach to be described later. Among the disadvantages of numerical classification are: (a) the time and expense required to define and develop descriptors, rate large samples of jobs/occupations on them, and carry out cluster analyses; (b) the necessity to develop descriptors and carry out analyses at more than one level of specificity; and (c) the possibility that numerical clusters may be less intuitively meaningful than rationally developed ones. It should also be noted that the quality of a numerical cluster structure rests on the adequacy of the descriptors, job/occupational sample, and analytical method on which it is based.

V. A STRATEGY FOR REVISING THE SOC

Considering the present stage of development in occupational classification/taxonomy and the comparative advantages and disadvantages of the rational and numerical alternatives, we propose combining the two approaches. Whereas the numerical method excels in large-scale data processing, the rational process can account for factors and subtleties that may slip through the numerical net. Accordingly, we think that the numerical method would prove useful in providing input to a rational evaluation and revision process.

Another basic premise for our proposal is that the revised SOC should be hierarchically structured (as is the present SOC), with small groups nested under large groups; e.g., broad divisions subdivided into major groups, subsuming minor groups that, in turn, subsume unit groups. In addition to its relative simplicity and parsimony, a hierarchical classification structure would allow different users to work at different levels of generality or specificity depending on their needs.

Finally, we propose that skill-level categories be introduced into the revised classification system. Consistent with several recently developed systems, we envision a broad level-by-content matrix or grid as an overarching classification framework.

A General Framework

Units of Analysis

The proposed approach to SOC revision involves collecting GWA rating data for occupations, which would require selection of a basic unit or object of analysis. Possible choices include jobs, DOT 9-digit occupations, SOC unit groups, OES 5-digit groups, or narrow occupational clusters (occupational units, or OUs) formed within the SOC or OES groups. To begin this effort at the job level, seems prohibitively time consuming and expensive, whereas the SOC and OES groups are probably too broad to serve as units of analysis, thus leaving DOT occupations and OUs as the surviving candidates. Because of their large number, only a representative sample of DOT occupations could be practically rated on GWAs, posing the question of how the remaining occupations would be assigned to groups. It would be practical, however, to rate the anticipated 1200-1500 OUs, which are our recommended choice as objects of analysis. A promising exploratory effort is currently under way to derive OUs by clustering DOT titles within OES 5-digit groups. For convenience, the units of analysis will hereafter be referred to as "occupations."

Content Divisions: Matrix Columns

The columns in the proposed matrix would be marked by content divisions analogous to those in the Canadian NOC or the BLS Job Family Matrix. The first step in column derivation would involve rating occupations on a general occupational analysis questionnaire (OAQ) containing IWA and FWA statements drawn or adapted from sources cited in this paper. (It might prove useful to condense the OAQ descriptors to more basic dimensions through factor analysis.) The occupations would be clustered based on their OAQ descriptor (or factor score) profiles, to produce an anticipated 25-30 broad occupational clusters. The resultant clusters would then be subjected to structured rational evaluation and revision, and the final products would be retained as classification divisions. These divisions would be characterized by the mean descriptor profiles of their constituent occupations, which would provide a basis for subsequent numerical-electronic assignment.

Skill-Level Categories: Matrix Rows

There are several possible conceptual and methodological approaches to defining "skill level," including: (a) educational and vocational preparation scales, (b) a cognitive complexity factor, (c) compensation level as captured through regression analysis by GWA or other factors, and (d) "expert" judgment on assignment of occupations to skill levels, as captured through discriminant analysis by GWA or other factors. We recommend the last option for consideration. Regardless of the method used to establish skill-level categories and assign occupations to them, their cross-classification with the content categories will produce a matrix or grid containing occupations within its cells. In subsequent discussion, we shall refer to the matrix columns as "divisions" and the matrix cells as "major groups."

Clustering Within the Matrix Framework

This phase of the proposed effort would focus on subdividing the major occupational groups (matrix cells) into smaller minor groups and occupational unit groups. For that purpose we recommend the development of an AWA rating questionnaire (AWAQ) for each of the 25-30 matrix divisions (columns). The division AWAs in these questionnaires might be supplemented with relevant IWAs and FWAs and perhaps, when judged necessary, AWAs specific to major groups. Occupations would be numerically clustered within each major group, based on their AWAQ descriptor (or factor) profiles, and minor-group clusters would be identified. The numerically derived minor-group clusters would then be subjected to a structured rational evaluation/revision procedure. Occupational groupings at the lowest or most specific level in the proposed system would be subsumed under the preceding minor groups. We shall call these "unit groups," consistent with the SOC terminology. If the previously described "occupational units" were used as the basic objects of analysis, then these would also serve as unit groups in the classification system. If, on the other hand, a representative sample of 9-digit DOT occupations were used as objects of analysis, more specific clusters, below the minor-group level, would be selected from the hierarchical structure to serve as the unit groups. Under this latter approach, the unit-group numerical clusters would then be subjected to structured rational evaluation/revision.

In summary, the proposed system would be structured within a matrix formed by skill-level rows crossing content-category columns. Occupations would be assigned to the matrix cells and hierarchically clustered within those cells. The content categories would be called "divisions"; the matrix cells, "major groups"; and the hierarchically arranged clusters within cells, "minor groups" and "unit groups" successively. The unit groups, in turn, would contain 9-digit DOT occupations. Groupings would be described at every level by their mean descriptor profiles. The descriptors would provide a basis for (a) electronic assignment of new occupations, (b) occupational grouping for special purposes, (c) later revision of the classification system as needed, and (d) estimation of occupational requirements for human capabilities and other attributes (as described subsequently).

The resultant skill by content level classification should be evaluated to determine the extent to which it would support the classification and coding functions as performed by the major agency producers of occupational information. Unit and minor groupings should be assessed to ascertain possible coding problems. Agency classification preferences should be identified, differences adjudicated, and acceptable compromises negotiated. Where groupings were judged to result in too small employment sizes to support statistical accuracy, adjustments should be proposed and corrective action taken. After a fixed time period, the classification system should be implemented as an operational standard.

VI. INTEGRATION OF THE DOT WITH THE REVISED SOC

SOC-DOT integration involves two major components: linkage of the SOC descriptors and the current DOT to the worker characteristics scales being developed by the O*NET project under the APDOT model, and organizing both existing and newly collected occupational data according to an acceptable occupational classification structure.

Linking Occupational and Worker Characteristics

A strong suit of nomothetic job descriptors (NJDs), such as the previously defined IWAs and FWAs, is their potential linkage to many of the previously defined attributes, particularly the more basic and fundamental capabilities. As mentioned, just as jobs can be characterized by work activities performed, human capabilities can be defined in terms of people's performance levels on specified classes of tasks (activities) as represented by items comprising tests. Many other personal attributes can be similarly defined. For example, work-related interests can be defined as preferences for specified classes of tasks as represented by the items comprising interest questionnaire scales, and work-related needs as preferences for broader classes of job rewards, opportunities, and conditions as represented in need scales. Thus, in attempting to establish a job or occupation's requirements for these attributes, one could ask to what extent the tasks represented in the tests are part of (or embedded in) the tasks performed in the job. Because IWAs and FWAs (hereafter referred to collectively as NJDs) represent concrete classes of work activities, we propose that they could serve as mediators in establishing job-test linkages--linkages between occupational and worker characteristics.

The proposed means of linking NJDs to human attributes has been termed the "job component" approach, under which (a) a universal set of job components (NJDs or NJD factors) is developed and (b) requirement weights are derived for the components on various human attributes. Subsequently, attribute-requirement estimates can be derived for any job or occupation that has been rated or scored on the weighted components. The job component approach, which has been tested with at least four NJD questionnaires, offers several advantages over direct global ratings of occupations' attribute requirements. Once a matrix of NJD attribute-requirement weights has been established, an occupation's attribute requirements can be estimated from ratings by knowledgeable respondents on relatively concrete NJDs representing observable work activities and conditions; i.e., the respondent is assigned the more straightforward task of indicating what the worker is required to do rather than inferring what attributes the worker must possess. Moreover, the job component approach provides a basis for explaining why an occupation requires a particular attribute (i.e., because it involves specified activities with those requirements), as opposed to relying entirely on the expert-judgment argument inherent in an occupation's direct attribute-requirement ratings. Finally, based on the Spearman-Brown prophecy principle, job component estimates of attribute requirements should show higher reliabilities per analyst/respondent, because they are derived from the respondent's ratings on a number of weighted NJDs, rather than from single global occupation ratings on each attribute requirement.

Thus, through job component methodology, the same descriptors used to develop a new SOC could be used to capture attribute-requirement variables in the current DOT and those developed recently on the O*NET project under the APDOT model. Cluster KSs, most of which are too specific to be captured by the NJDs, would instead be reflected directly in AWAs or AWA factors.

Occupational Classification and Description in a SOC-Structured DOT

Under the proposed approach, the DOT would be organized according to the revised SOC structure. Although the new DOT would still be hierarchically arranged, its current categories, divisions, and groups would be replaced with the new SOC divisions, major groups, minor groups, and occupational units (or unit groups). The 9-digit DOT occupations would be retained and subsumed under occupational units. Because the new classification system would be skills oriented, it should promote the purposes of the DOT as outlined in the APDOT (1993) report. New occupations could be electronically assigned to the classification system based on their numerical profiles on the descriptors used to develop the system. The same descriptors (GWAs), if made available to the field in the form of structured job analysis questionnaires (on computer or hard copy), could be used to rate jobs and classify them within the taxonomy. The system would also facilitate the classification of job tasks and duties, which could be sorted (by the employer or other user) into the salient AWAs of their respective occupational units, thereby incorporating them into the system. Input from other sources, such as the large task/duty inventory compiled by V-TECS and task lists developed by the State of Michigan (McCage, 1994), could also be brought into the system. Over a period of time, extensive task/duty banks would be compiled for the AWAs and their superordinate IWAs. One might envision a comprehensive, vertically integrated occupational information/classification system with a wide range of uses. The system descriptors could, of course, also be used to profile, compare, and group jobs/occupations in a variety of other ways according to specific user needs (i.e. to develop custom-made classification structures).

The taxonomic variables (GWAs) used in developing the classification system would provide a basis for describing groups at different levels in the hierarchy, based on their descriptor profiles, with the descriptions becoming more general as the classification categories broadened.

Through either job component methodology or direct representation, the classification variables would also capture the variables in the APDOT model, making those available for occupational description as well. The descriptions could be presented in two different forms: (a) the numerical profiles for occupational units and groups and (b) textual descriptions using salient descriptors as building blocks or modules, perhaps supplemented with task/duty examples (from banks compiled under AWAs) and classes of equipment and materials used. Information about specific occupations or groups could be delivered to the user electronically. Job ratings on the aforementioned descriptors could be entered by the user into an electronic information system which, in addition to classifying the job, would "synthesize" a tailored job description from the system building blocks. The job ratings in turn, when compiled over a period of time, could prove helpful in DOT system maintenance and revision.

Because the GWAs would either directly represent or capture various knowledges, skills, and abilities (KSAs), they could provide a basis for inventorying human resource pools. Large employers, for example, could compile human resource capability inventories based on numbers of employees trained and/or experienced in various jobs and job groups requiring specified KSAs. Such information would be useful in organizational planning and development. This approach might even be extended to local, regional, and state populations based on OES and Census data showing numbers of people employed, trained, and/or experienced in different occupational groups, which in turn would be profiled on KSA-related variables. Potential users of population KSA data might include employers, industrial recruiters, Chambers of Commerce, educational institutions, and government agencies. The KSA-related descriptors (or their factors) might also be treated as transfer dimensions with applications to such problems as job consolidation, multi-functional/cross-job training, and the determination of job transfer and advancement paths. Conceivably, KS training modules could be developed based on occupational and/or GWA clusters, to be drawn upon in the design of institutional and organizational education/training programs. Skills competency/certification tests could be developed on a similar basis. Other applications might be found in areas of job analysis and design, such as: the development of enriched, "high performance" jobs; identification of performance assessment dimensions; teamwork analysis and team building; and identification of essential and nonessential components in jobs for ADA compliance.

In addition to providing for the classification and description of jobs/occupations and their requirements, the proposed system would (as already suggested) provide a framework for describing the associated characteristics, training, and work experiences of people in terms of the GWA-captured APDOT attributes as well as KSs represented directly by GWAs or GWA factors. Some of these variables would be assessed by psychological measurement devices, while others would be represented by educational, training, and work records. Such descriptors, when applied to individuals, would provide information about the person that could be linked electronically to job/occupational information within and across organizations, thus facilitating the person-job matching process. Large employers could develop electronic job and personnel information systems with applications in human resource planning, development, and utilization. Other applications could be found in such areas as career exploration, guidance, and choice;

employment counseling and placement; disability determination; and vocational rehabilitation.

The potential advantages of the proposed approach seem apparent when one considers the vast amount of occupational information to be dealt with, the rapid changes occurring in the world of work, and the capabilities of current electronic systems to store, process, and update large data sets. A numerical-electronic system would be in the true spirit of APDOT's envisionment of an occupational database for the 21st Century.

I. ORIENTATION

The Standard Occupational Classification (SOC), first published in 1977 and updated in 1980, is scheduled for a major revision in 1997. The Bureau of Labor Statistics (BLS) has been assigned lead agency responsibility for the initiation and coordination of a comprehensive revision effort. BLS in concert with the Employment and Training Administration (ETA) has initiated a series of activities designed to produce a revised SOC for use in the forthcoming decennial census. Early activities included the commissioning of a series of papers presented at the International Occupational Classification Conference sponsored by BLS and held June 22-24, 1993 at Washington, DC. The papers, discussion comments, panelists' remarks and audience input were subsequently published as conference proceedings. As a follow-up to these efforts, the SOC Revision Policy Committee has commissioned six papers to address the issues and options of SOC revision in greater detail. This paper is one of the commissioned works.

The general purpose of this paper is to explore the issues and options associated with the development of a skills-oriented SOC. More specifically, this paper seeks to identify, organize and elaborate upon the conceptual and methodological issues associated with the development of a skills-oriented SOC; to develop methodological options for resolving identified issues; and to suggest a recommended framework for SOC revision. It is intended that the proposed procedures be sufficiently detailed so as to provide a general methodological framework, yet retain adequate flexibility to accommodate subsequent technological and administrative contingencies.

The paper is organized according to six chapters. Chapter II will be devoted to an identification and analysis of the major issues underlying the development of a skills-oriented SOC. Issues will be distilled from a synthesis of the major literature with direct relevance for SOC revision. Chapter III will present classification principles derived from the issue analysis and intended to support subsequent procedural recommendations. Chapter IV will be devoted to a discussion of conceptual and methodological approaches to framework development. Chapter V presents a general strategy for the SOC revision. Chapter VI will conclude with a meta vision as to how a revised SOC and a reinvented DOT might be integrated into a unified occupational database.

II. ISSUE IDENTIFICATION AND ANALYSES

Before proceeding, a definition of issue is in order. As used in this paper, the concept of issue implies a choice. Issueness arises when there is not clear-cut agreement on the values accruing to differential choices. Uncertainties frequently exist as to the technical and political feasibility of decision options as well as the expected consequences of choosing specific options. In recognition of the underlying uncertainty, issues will be phrased as "can" and "should" questions. Can-oriented questions reflect an uncertainty as to the likelihood that a state of affairs is physically achievable. Should-oriented questions reflect an underlying uncertainty as to the wisdom of obtaining a particular state of affairs. In this paper, both can and should questions will be used to frame issues.

Issues to be subsequently discussed were identified based upon a screening of secondary data sources. A principal source was the Proceedings of the International Occupational Classification Conference (1993), hereafter referred to as Proceedings. Papers, comments and remarks presented in the Proceedings were supplemented by a review of the occupational cluster papers prepared in conjunction with DOL's skill standards initiative. Further information was derived from an examination of SOC-related documentation and a review of the professional literature having special relevance for occupational classification.

Based upon an examination of the above sources, candidate issues were identified. Issues were sorted, combined so as to reduce overlap and redundancy and edited to sharpen clarity and focus. The final issues so identified were grouped by content similarity into four major classes. The first deals with the major purposes/usages of a revised SOC. The second discusses issues associated with the introduction of skill as a classification principle. The third relates to classification-related issues, and the fourth with issues pertaining to linkage of the SOC with other systems. Issues assigned to each of the above classes will be individually discussed.

SOC Purposes/Uses

The major contention is whether a revised SOC can or should be used for both statistical and programmatic purposes. Historically, the SOC has served primarily a statistical purpose. As the 1980 SOC revision states, the SOC is ". . . designed for use in statistical analysis and presentation of data about occupations. It was not developed for any particular programmatic use" (1980, p. 4). In a recent OMB draft document, the statistical purpose was reaffirmed by the assertion that the SOC ". . . is designed to maximize the analytical utility of statistics on labor force, employment, income and other occupational data collected for a variety of purposes by various agencies of the United States Government, State agencies, professional associations, labor unions and private research organizations" (1994, p. 3).

The historical context was an early governmental focus on the collection of occupational demand and supply data. The major federal agencies with responsibilities for collecting occupational demand and supply data were BLS, with its Occupational Employment Statistics

(OES) program, and the Bureau of the Census. The then Office of Education and later the Department of Education collected supply-side data to the extent that vocational programs could be matched with DOT codes. Demand-supply linkages were tenuous due to co-existing occupational classification systems and a lack of crosswalks for linking one to the other. The SOC was originally formulated to resolve these cross-classification difficulties. Responsibility for SOC development was assigned to the Office of Federal Statistical Policy and Standards, U.S. Department of Commerce as a neutral agency. By networking all occupational data to the SOC system, linkages to existing occupational demand and supply systems were thought to be achievable through the use of appropriately constructed crosswalks.

The era of inter-system coordination that spawned the SOC extended to other institutional arrangements. The Vocational Education Amendments of 1976 created the National Occupational Information Coordinating Committee (NOICC) and mandated the coordination of occupational information delivery and use at federal and state levels. During approximately the same period, the Comprehensive Employment and Training Act (CETA) stipulated that the SOC and/or equivalent system be used to guide the collection of occupational supply data (SOC Manual, 1980). The thrust of these legislative mandates was to promote the usage of occupational data for the planning, administrating and evaluating publicly supported education and training programs. NOICC and its network of state occupational coordinating committees originally confined their activities to issues surrounding the development and use of occupational information systems at state and local levels. As the NOICC/SOICC system matured, its sphere of activities widened to include the development and promotion of career information systems.

During the 1960s and 1970s, the market for occupational data was driven primarily by federal government reporting requirements. Reporting requirements mandated in the legislation stimulated the demand for standardized and uniform classification and collection procedures. As government requirements dwindled in the 1980s, the market for occupational data became more segmented with demands driven by specialized purposes and intents. Certain programs like OES and the Census have remained relatively unchanged. Others like the Dictionary of Occupational Titles (DOT) are in the process of reinvention to better serve the needs of the twenty-first century (APDOT, 1993). Vocational education and CETA, now JTPA, use of occupational information has shifted from compliance reporting to the support of local program purposes. Increasing attention on the needs of the differently abled has created a rising constituency who are demanding access to a database of occupational information. The growing realization that modern organizational structures must change from the rigid strictures of the past to a more flexible form supportive of global competitiveness is focusing national attention on the need for workforce development. The Goals 2000: Educate America Act with its emphasis on national skill standards and certification, the work-based learning initiative of DOL, the reinvention of the DOT, and indeed the current activities associated with SOC revision, all reflect a context in which the collection of occupational information becomes a means for a larger collective purpose rather than a singular end unto itself. It is within this larger context of change that the issue as to the purpose of a revised SOC must be regarded.

What Should Be the Principal Purpose of a Revised SOC?

A question of purpose requires an examination of the primary functions performed. As the title indicates, the SOC is first and foremost an occupational classification system. As a classification system, the SOC facilitates the performance of three central functions: classification, coding and crosswalking. Each function can be further subdivided into two major activity classes: those activities associated with the construction of a system that will provide a means for the achievement of that function and those activities involved in the continual use of the system to achieve that function. Thus, in each function there are activities that are production oriented and those that are consumer or user oriented. The implication of these activities for a determination of principal SOC purposes will be discussed in turn for each of the three major functions.

Classification. Classification activities are of two kinds: those associated with development and construction of an occupational classification system and those devoted to the use of the classification system to serve a variety of user needs. Development of a classification system is a taxonomic endeavor guided by classification principles as exemplified by the twelve principles used in the 1980 SOC revision. Occupational classification taxonomies are generally hierarchical with a limited number of taxonomic levels. In the case of the SOC, the taxonomy is structured according to division, major, minor and unit groupings. Use of the taxonomic structure for classification purposes generally involves placement of an object which is a member of the set of things to be classified, in this case occupations, into a grouping that provides the finest possible discrimination. The finest possible level of discrimination is not always the lowest taxonomic level, e.g., unit groups in the SOC. For example, a significant number of minor groups in the SOC have no unit group subclassifications so that the minor group itself becomes the lowest level for that branch of the hierarchical tree. The user's task as classifier is to take an object, generally an occupational title, and to assign that title to the lowest possible grouping in the taxonomy having the best fit. Fit in this case is defined in terms of membership criteria. It is the classifier's responsibility to make the final assignment decision based on the classifier's understanding of group membership requirements intrinsic in the taxonomic structure and whatever information is contained in the occupational title and/or supportive data.

Examination of classification usages and users further elucidates the issue. Drayse, Dubinsky, Flaming and Law have identified the following workforce outcomes that would require occupational classification: workforce entry and reentry, reemployment, career ladders, competency identification, optimal job matches, worker empowerment, national comparability of work, international comparability of work, management of change, and research (Drayse, et al., 1994). The Advisory Panel for the Dictionary of Occupational Titles (APDOT, 1992) identified eleven categories of DOT use: alien labor certification, career and vocational counselling, curriculum development, DOL program functions, disability determination, employment placement, human resource development/human resources management, labor market information, occupational information development and dissemination, research, and vocational rehabilitation. While these uses pertain to the DOT, they serve to illustrate a range of uses for occupational information. Whenever and wherever occupational information is used, a classification system is required to superimpose logical order. The use of a classification system differs somewhat depending upon whether the user is a producer or a consumer of occupational data. For users who are producers, classification systems contribute to sampling design and data collection in that they provide a rationale for grouping, as well as providing tabular rationale for the presentation of data. Consumers tend to be concerned about the occupational coverage of the classification system, the classification principles that dictate how occupational groupings are combined or separated as the case may be, and the appropriateness of the granularity of the occupational classification system for their intended uses.

Coding. Coding involves (a) locating the most appropriate grouping at the lowest level of the taxonomic system in which to place the object to be coded (most likely an occupational title) and (b) affixing a code to the object that represents a mnemonic description of the class to which the object has been assigned. Thus, coding is primarily classification with the additional requirement that a code be assigned to the object indicative of the grouping to which the object has been assigned. As with classification, coding activities can be distinguished according to whether they pertain to the construction of the coding system or to the use of the coding system. Coding systems are generally constructed so as to provide a trail from the highest to the lowest level in the taxonomy, culminating in a specified grouping at the maximum level of detail provided by the taxonomy. Coding is generally numeric with digits being assigned to each of the major taxonomic levels. Codes are frequently concatenations of the levels required to move from the highest to the lowest level in the taxonomy. For example, the OES system identifies each occupation by a five-digit code. The first digit in the code represents the taxonomic division in which the occupation to be coded is located, the next digit signifies the major group, the third the minor group, and the last two digits represent the ordinal positions of all the occupations in the classification described by the first three digits (McElroy, 1994). Both the SOC and the Census systems have a similarly structured coding system. Although employing similarly structured coding systems, the OES and Census classification systems differ markedly in their coding procedures. In the OES, occupational data is collected by an establishment survey which requires that employers code their workforce in accordance with OES coding structure. In contrast, the Bureau of the Census collects occupational data through household surveys where the respondent provides only a job title. Coding of the title to an appropriate occupational grouping is done by professional coders at a centralized location. Users of the DOT provide yet another example of the coding of occupational information. Anyone who uses the DOT to match an uncoded occupation and subsequently assigns a DOT code to that occupation is performing a coding function. Coding activities require matching the target occupation with one or more possible DOT titles, deciding which of the alternative titles best describes the target occupation, and assigning the code of the occupational description judged most relevant to the occupation to be coded. Perhaps the largest institutional DOT use of occupational coding is the coding of job requests from employers by Job Service placement specialists.

Crosswalking. Crosswalking refers to a procedure for linking comparable occupational groupings across different occupational classification systems. Over the years, crosswalks between the OES, Census, SOC and DOT have been developed as the need arose. The SOC-DOT crosswalk is intrinsic to the SOC system as listings of DOT assignments to unit groups are provided. The fourth edition DOT creates a DOT-SOC crosswalk by listing the corresponding SOC code in the definitional trailers accompanying each DOT code. Both BLS and the Bureau of Census individually have prepared crosswalks linking their classification systems to the SOC (MacDonald & Hadlock, 1994). As might be expected, experience has shown that construction of crosswalks is fraught with comparability difficulties. For a discussion of the problems associated with linking data across different occupational classification systems, see Rosenthal (1994).

In addition to the aforementioned crosswalks, other crosswalks have been developed linking occupational and educational systems. The crosswalking work done by NOICC and their SOICC network provides an outstanding example. NOICC has developed the Vocational Preparations and Occupations (VPO) which serves as a crosswalk between vocational programs and occupational titles. NOICC sponsors a National Crosswalk Service Center (NCSC) as a technical resource center. NCSC maintains a NOICC master crosswalk that contains a unified linkage between all contemporary occupational classification systems. This center provides customized crosswalking services upon request, and has been an invaluable resource in supporting the development of state occupational and career information systems.

Summative Conclusion. Occupational classification and coding are the twin functions that must be supported by a revised SOC. The need for crosswalking was one of expediency due to the lack of a truly standardized occupational classification system. To the extent that occupational classification systems serve idiosyncratic agency needs, crosswalking will continue to be a necessary auxiliary function. Conversely, to the extent that a *standardized* system emerges, the demand for crosswalking capabilities will fade as alternative systems merge into a single entity.

Should a Revised SOC Attempt to Balance Counting Accuracy With Descriptive Detail?

Drayse, et al. draw a distinction between *sorting variables* and *supplementary variables*. According to the authors, the sorting variables are those used to ". . . define and aggregate occupations" (Drayse et al., 1994). As the term suggests, supplementary variables are data elements not used to form occupations but instead to provide added detail about the already formed occupations. Stevens suggests a similar bifurcation by noting that the major goal of a revision process should be ". . . to squeeze more value-added out of the combination of counting capability and definitional detail" (Stevens, 1994). Both authors suggest a dual purpose for occupational information---one being the definition of occupations and the other being the description of a priori defined occupations.

The distinction between sorter and auxiliary variables or a related distinction between definitional and descriptive variables provides a sound rationale for the bounding of SOC responsibilities. Definitional specification should be a SOC responsibility. Supportive descriptive detail should be provided by an occupational database as envisioned by APDOT (1993). Descriptive detail in a revised SOC should be limited to that necessary to perform the classification and coding functions as previously defined. Occupational detail not directly utilized in the definition of occupations should be functionally separated and regarded as a database design and development responsibility. Focus on definitional detail to the extent necessary to support occupational classification and coding would provide for a natural separation of the functions. Functionally separating SOC revision from database development would, of course, require considerable cross-functional coordination in order to ensure the development of an integrated occupational database capable of supporting both statistical and programmatic requirements.

It has been suggested that an occupational database could be developed with the on-line capabilities of sorting into near infinite combinations, thereby precluding the necessity of any SOC-like system. While undoubtedly technically feasible, this suggestion discounts the utility of standardized and uniformly presented occupational information. Without a SOC to impose definitional order, occupational classifications would have no uniform meaning. Data interpretation would be seriously compromised. In the absence of uniform definitions, comparability of data across collection modalities would be exceedingly hazardous. Time series comparisons would be prohibited and employment projections rendered impossible. Policy applications of occupational data would be seriously curtailed and national skill standardization and certification efforts excluded.

Summative Conclusion. The SOC is a necessary component in the design, development and use of an occupational information database. The SOC performs an integrative function by providing the definitional uniformity and the occupational structure necessary for the identification, collection and presentation of supportive occupational descriptive detail. Thus, the SOC provides the taxonomic structure and definitional detail that when supplemented with auxiliary data organized by taxonomic levels will constitute an occupational database. Although an integral part of an occupational database, the revised SOC should be designed to have stand-alone capability. Major occupational data producers such as BLS and Bureau of the Census need direct access unencumbered by unnecessary descriptive detail. Consumers of occupational information, on the other hand, find that auxiliary detail is essential to their intended purposes. The necessary balance between counting accuracy and descriptive detail will be dependent upon the extent of coordination and cooperation between agencies responsible for SOC revision and those responsible for the development of a supportive descriptive database. Recommendations for the development of an integrated SOC-DOT system will be presented in Chapter VI.

Can or Should a Revised SOC be Useful for Both Household and Establishment Survey Sources?

The issue is whether agencies using different data collection sources can be served by a common classification system. By virtue of its charge, the Bureau of the Census directs its data collection efforts at where people live rather than where they work, as is the case with the Bureau of Labor Statistics' OES program. Differences in collection methodologies have direct implications for occupational classification and coding. The law of requisite variety stating that **only variety can destroy variety** has relevance for the issue at hand (Buckley, 1968, p. 135). Applied to occupational coding, this law states that coders can only code to the level of occupational detail supported by the data collected. In the case of household surveys, insufficient detail to allow coding at the unit level results in placement in a minor group. A typical example is the difficulty encountered in differentiating between SOC major groups 73-74, "machine set-up operators", and 75-76, "machine operators and tenders", due to a lack of survey detail as to whether reported machine operators did in fact set up their machine or not (Scopp & Priebe, 1994). Other compatibility problems center on agency preferences for specific combinations at the unit and minor groupings and self-imposed limitations on the number of divisions to be used for tabular summaries. Data producing agencies having a primarily statistical orientation, often place greater emphasis on questions of data reliability than occupational classification standardization. If data reliability conflicts with occupational classification integrity, OMB reportedly tends to favor data quality over absolute adherence to the SOC (Rosenthal, 1994).

Summative Conclusion. The issue apparently seems to involve a mixture of technical considerations and agency preferences. Coding problems with household surveys can be resolved by one of two basic ways: code at the level of occupational detail permitted by the survey at the risk of sacrificing detail at the unit level or modify the survey so as to collect additional occupational detail. Modification of survey forms might include inclusion of contingency questions designed to collect more occupationally specific data, perhaps modeled in some respects after the checklist forms used by Ohio (Sommers, 1994). Enforced adherence to a revised SOC would seem to curtail current agency tendencies to solve technical problems by deviating from SOC standards.

Should the SOC Revision Incorporate a Major Change in Classification?

Resolution of this issue depends upon the decision to move to a skills-based SOC and the amount of revision necessary to accomplish a skills-based transformation. These uncertainties notwithstanding, the simple requirement that all occupational data producing agencies adhere to the same occupational standards will necessitate changes in BLS and Census data classification procedures. In a comparison of the OES with the current SOC, McElroy (1994) described differences in the number of detailed occupations, instances in which the OES split a SOC occupation into more detail categories, examples in which the OES combined occupations that were separate in the SOC, and some few examples where comparable OES and SOC occupations were in different divisional levels. Comparable problems with SOC-Census compatibility were documented by Dempsey (1994). It is extremely doubtful that any proposed SOC revision would be successful in significantly reducing these classificatory discrepancies. Enforcement of a revised SOC even with but minor structural changes would still require agencies to modify their collection and coding procedures with consequent developmental and retraining costs. Any change in data collection and analysis procedures will have implications for time series compatibility. At this point, options for a SOC revision range from mere tinkering to a major structural alteration. Considering the stakes and the role that the SOC might play in the transformation to a high performance society, modification costs pale in comparison to the costs of opportunities lost by squandering the present momentum.

Skills-related Considerations

Of all the issues, those related to skills are the most problematic. Definitional confusion arises because of the failure to differentiate conceptually between work and worker. For the purposes of this paper, we shall define work as being characterizable by a set of activities. These activities are considered as action requirements in that they stipulate what work must be performed. We have intentionally chosen activities as opposed to behaviors to emphasis the distinction between work to be performed and the means chosen for its performance, which could be either human or nonhuman. Activities are a generic statement of what needs to be done in order to produce a good, service or product. Although not a necessary restriction, activities have traditionally been used to describe human work. In contrast, worker attributes are generally defined as ascribed traits of the human organism. A differentiating condition is that activities are properties of work while attributes are properties of the worker. Both activities and worker attributes vary along a specificity continuum ranging from those applicable only to a single occupation to those applicable to the entire spectrum of occupations. The APDOT Content Model delineates five levels of worker attributes or skills: (1) abilities and aptitudes, (2) workplace basic skills, (3) cross-functional skills, (4) occupational-specific skills, and (5) occupational-specific knowledge (APDOT, 1993). As we shall argue in Chapter IV, this skills continuum can be paralleled by an equivalent activity continuum. Occupation-specific activities are exemplified by the duties and tasks descriptive of the work performed at the occupational level. At increasing levels of generality, we propose area work activities, intermediate work activities and foundation work activities which, as the title suggests, are at a sufficiently broad level of generality to be applied to all work performed independently of content. We intentionally postpone further definitional detail until Chapter IV. Our purpose here is to draw the major distinction between activities and attributes.

A key advantage of work activities is that once identified they are sufficient for the definition of skill. If the work activity is "uses an inside micrometer to adjust machine," then the corresponding occupation-specific skills is simply the "ability to use an inside micrometer to adjust a machine" (Harvey, 1994). This definitional equivalency between work activities and skill is reflected in the APDOT definition of an occupation-specific skill as "The developed ability to perform given general or specific work activities that tend to occur across relatively narrower ranges of jobs . . . " (APDOT, 1993, p. 33). We posit that this equivalency between work activity and skill continues to hold even at higher levels of occupational generality. However, as Harvey cautions, the skills become increasingly less observable and more abstract as the work activities become more broadly defined. This is mainly a measurement problem, however, and does not detract from the main point that work activities and worker attributes are inextricably linked.

Should the Revised SOC be Based on Skills or on Work Performed?

As the above discussion suggests, the distinction between work performed (work activities) and skills is largely artificial. Work activities and worker attributes form a dialectic bond. Neither has meaning without the other. Human work implies the attributes (skills) to perform the work. Worker attributes imply that work is to be accomplished. Which side of this dialectic relationship is highlighted depends upon the purposes to be accomplished.

Summative Conclusion. From an economic and social perspective, the structuring of work performed is a basic societal function. The fundamental nature of work performed has been historically recognized by occupational analysis. In fact, it was the near total focus on work activities that caused psychologists like E.J. McCormick to champion a more worker-oriented approach. As a result, work activity and worker attributes are today considered as the twin domains of the world of work.

With due recognition of this duality, we propose that work performed be the classification basis for a revised SOC. We do this for three separate but related reasons. First, work activities are the fundamental units of our economic system. Second, work activities are more readily definable than worker attributes. Lastly, worker attributes can always be inferred from work activities.

Is There an Inherent Advantage in Classifying Occupations by Skills Level and Skills Type (Content)?

Use of occupation as an indicator of socio-economic status (SES) has a long history. Hollingshead (1949) was an early pioneer in the development of SES scales. Sociologists have long held that labor markets are structured by skills and that employees can be "placed in stratified skills hierarchies . . ." (Berg, 1979, p. 64). Although not explicitly acknowledged, most occupational taxonomies implicitly classify occupations by skills level. As Seymour Wolfbein notes ". . . I have yet to see (although I cannot claim to have seen every tabulation made in this area) a table on these matters which does not begin with executive and managerial occupations, moves on to the likes of engineers, life scientists, diagnosing occupations, and so on, all the way 'down' (my word) to handlers, helpers, and laborers" (Wolfbein, 1994). Secretary Reich has explicitly recognized a skills leveling in his classification of the American workforce as symbolic analysts, in-place service workers and routine production workers (Reich, 1992). Interest in skills leveling stems from the conviction that America must move from a preponderance of low-skilled "bad" jobs to an emphasis on high-skilled "good" jobs in order to survive in the global marketplace. Contemporary occupational classification systems not structured to reflect differences in skill levels will be unable to directly address changing workplace skill level requirements.

Skill type is a companion concept often discussed in tandem with skill level. Popkin (1994) offers a discussion of skill level and type; however, his discussion of type is limited to a discussion of exemplary instances drawn from the literature. Madden and Tam (1994) in their description of the Australian classification system describe a concept of skill specialization based on field of knowledge, tools or equipment used, materials worked on and goods or services produced. This is strongly reminiscent of the MPSMS taxonomy of the DOT, reinforcing the contention that the DOT has a skills orientation, albeit implicit in the structure. Skills specialization in the Netherlands system is operationalized according to educational sectors (Bakker, 1994). The National Occupational Classification of Canada (NOC) defines skill type according to nine major classes of work performed (Roberts, 1994).

Summative Conclusion. Classification of occupations by skill level and type appears to have considerable merit. Occupations have long been regarded as a principal determiner of SES. Changing world market conditions are mandating that America's workforce be developed to meet its changing workplace requirements. The task is not as formidable as it might first seem. As Wootton (1994) correctly concludes, " 'Skill-based' occupational classification structures are not so different from those based on 'work performed' (p. 332)." International experience has demonstrated the feasibility of developing a skill level by type classification system. It but remains for the United States to apply its ingenuity to the development of a skill level by type classification system tailored to the nation's unique needs.

Is Required Educational Level an Adequate Indicator of Skill Level?

Skill level is frequently equated with the human capital requirements of formal education, training and experience. These human capital requirements are mirrored almost exactly in the Australian system, where skill level is defined as ". . . the amount of formal education, on-the-job training and previous experience required before an individual can perform that set of tasks satisfactorily" (Madden & Tam, 1994). In the Netherlands system, skill level was operationalized by determining the most adequate training program defined as the one best preparing workers for the duties and tasks required (Bakker, 1994). The Canadian NOC utilizes four broad skill level categories which combine formal education, apprenticeship and/or specialized training, on-the-job training and relevant occupational experience (Roberts, 1994).

Similarity of use should not be misconstrued as a consensus of the suitability of educational attainment as a measure of skill level. Representative criticisms include "The limiting nature of schooling and experience suggest that it is necessary to find an alternative approach . . ." (Popkin, 1994); "The easiest thing to do is to slide into a substitution of training and educational level for skill" (Flaming, 1994); ". . . we want to be aware of what one might lose in any easy equation of skill with level of education" (Scoville, 1994); ". . . among workers in our country who are not college educated, there is quite a differentiation in the skill level" (Wootton, 1994).

Summative Conclusion. While the potential utility of skill level in an occupational classification system is generally acknowledged, no such agreement exists for its measurement. Considerable apprehension has been expressed concerning the capability of educational attainment to capture the nuances implied by skill level. A suggested approach is to abandon the mono-operationalism and to employ multiple factors as definitional indicators. An intriguing possibility is to extend the concept of job evaluation to apply to occupations. Just as jobs are assigned pay levels, it should be possible to assign occupations to skill level using **specially selected leveling variables**. Leveling variables are occupational descriptors which on the basis of a priori experience are known to differentiate occupations. Examples might be measures of cognitive complexity, creativity, resource control, wages and educational requirement level. The important consideration is that skill level would be operationalized by a triangulation of multiple indicator variables. A further elaboration of this concept will be provided in Chapter V.

What Role Should Wages Play in the Determination of Skill Level?

Wages have been suggested as a means of formulating occupational grouping. Triplett has proposed a hedonic approach wherein wages could be predicted by regressor variables capable of differentiating worker skills (Popkin, 1994; Loewenstein & Manser, 1994). According to this proposed method, if the wages of two separate groups of workers had the same regression structure, then worker groups could be combined into a single occupation. This approach, while theoretically consistent with economic principles, requires more extensive labor market information than is now available.

Loewenstein and Manser (1994) reported the results of an empirical study using wages to group occupations. With wages as the dependent variable and three-digit 1970 census occupational codes as predictor variables, they found that between occupational wage differences accounted for nearly one-third of the total wage variability in their sample. The remaining variability was due to within-occupational wage differences. In order to determine the effects of occupation with human capital variable held constant, human capital indicators were first used as regressors followed by the inclusion of occupational grouping variables. The addition of the occupational classification variables allowed Loewenstein and Manser to account for an additional 14 percent of the variability in the dependent wage variable. This provided clear evidence that wages are influenced by occupation and that this influence exists above and beyond that of human capital variables.

Summative Conclusion. That mean wages differ by occupational category even when typical human capital variables have been partialed out argues for the inclusion of wages in any function designed to allocate occupation to a skill level. The major problem with wage data is not conceptual but rather one of general availability. BLS has recently initiated the OES wage survey design to collect estimates of numbers of people employed by wage range and estimates of median and mean wage rates for OES occupations. Currently, fourteen states are participating in the initiative (McElroy, 1994). Wage data are reportedly being collected at the three-digit OES level. Whether wage data collected at this level of aggregation will be useful for the classification of occupations by wage level is highly problematic. The information available at this time suggests that while the inclusion of wages is based on a sound rationale, the practical utility of their inclusion remains to be determined.

How Should Skills Transferability Across Occupations be Operationalized?

Knowledge of the extent of skills transference across occupations is essential for workforce development. The massive restructuring required to shift from the structural rigidities of the past to the flexible and adaptive forms being increasingly demanded has major skills implication. Efficiencies in the organizational transformation from fixed to flexible require that existing skills be utilized to the maximum feasible extent. Organizational restructuring coupled with consequent downsizing is resulting in extensive job displacement. In this context, the issue of skills transferability takes on critical importance. In recognition of this central role, APDOT identified skills transferability as a major skills issue and defined the concept as ". . . those skills that are common to more than one occupation" (APDOT Interim Report, 1992, p. 14).

Although widely acknowledged as a central issue, remarkably little is available regarding its operationalization. The construct of transferability connotes the conveyance of something from one object/event to another. In this sense, transferability is akin to communication with a message being sent from an initiator to a receiver. Pushing the analogy further, one can focus on the content of the message or the process by which it is sent. In skills transferability, the emphasis has been primarily upon content rather than process. Skills transferability as noted above has been traditionally defined as skills commonly required by two or more occupations. Emphasis on content predisposes operationalization efforts to focus on the identification of the bundle of skills held in common. This leads to a multiplicity of skills and situational interactions which is counterproductive to a conceptualization of skills transferability as a unitary construct with applicability across occupations.

Consideration of skills transferability as a process avoids the content trap. Using a process model, the important question then becomes what is the process that supports or is sensitive to the conveyance of skills from occupation A to occupation B. The simplest and most direct answer is **retraining**. Other institutional factors being equal, one can posit a direct relationship between retraining and skills transferability. The shorter the retraining time the greater the skills transferability. Conversely, the longer the retraining time the less the skills transferability. Wootton in describing the Australian classification system noted that ". . . workers in the same occupation are supposed to have within-group mobilities; that is, if they are performing one job within the group effectively, they are expected to have the skills necessary to perform another within the group, without needing to undergo extensive retraining" (Wootton, 1994). What Wootton was describing is an implicit operationalization of skills transferability using retraining time as a proxy.

We realize that retraining time is significantly determined by education and training required for occupational entry. Furthermore, the higher the skill level of an occupation, the greater the retraining time generally required to make lateral shifts within a skill level. For example, more retraining would undoubtedly be required for an orthopedic surgeon to move to cardiology than to become a real estate agent. The problem with downward compression is not resolved by retraining time. However, the proposed use of retraining time is restricted to rather well-defined technological content areas with potential mobility defined as movements within these content areas. In this manner, the downward compression effects are minimized.

Summative Conclusion. Use of retraining time as a proxy for skills transferability has considerable intuitive appeal. Retraining time is a unitary construct that is readily scaleable. The same scale can be used to assess transferability between any pair of occupations, thereby providing a common metric across applications. Retraining time parallels in intent the Specific Vocational Preparation (SVP) scales used in the DOT. The utility of the SVP scales as expressed by frequency of citation in the Proceedings lends credence to the proposed use of a retraining scale for the operationalization of the extent of skills transferability. The critical distinction to note is that retraining time measures the extent of skills transferability as opposed to identification of the skills being transferred. Resolution of that issue is the subject of the next section.

Classification-related Issues

Classification is the central methodology in the development of a revised SOC. Choice of major classification methodology will dictate content, form and format with consequent influence on users and usages. The major choice is whether a revised SOC should be based on a numerical or rational classification. In numerical classification, occupations would first be described on a set of quantitative sorting variables. Each occupation would be defined in terms of a profile of scores on the set of sorting variables. Similarity indices would be created for each pair of occupations based on the similarity of their sorting variable profiles. The greater the match between profiles, the higher the similarity index. Clusters of occupations would be formulated using a selected algorithmic clustering procedure that would seek to obtain maximal homogeneity of the occupations within a cluster and maximum heterogeneity between clusters. Once obtained, numerically based clusters could be submitted to subject matter experts who would review the clusters for meaningfulness and rearrange the cluster structure as necessary to create meaningful results. Numerical clustering generally proceeds in a bottoms-up fashion, formulating clusters at increasing levels of generality.

Rationale classification takes an opposite tact. Classification proceeds from the top down. A first-level divisional structure is deduced from a set of premises regarding the hypothesized occupational structure. Once a divisional structuring is attained, the process is repeated at successively finer grains of differentiation as typically indicated by major, minor and unit groupings. The classification structure emerging from the common mental models of the constructors is highly idiosyncratic. As opposed to the numerical approach, the clusters in the rationale method are formed by splitting higher level clusters to form groupings at a more specific level. Rules for cluster formulation are largely tacit and thus not easily communicated. Since no explicit sorting variables are utilized, cluster profile scores cannot be included as accompanying descriptive variables as they easily could in a numeric approach.

Choice of a classification methodology depends upon resolution of a number of classification-related issues. Subsequent discussion will seek to identify and explore the ramifications of component issues.

What is an Occupation?

The traditional answer is that an occupation is a cluster or grouping of similar jobs, that a job is a grouping of similar positions, and that a position is a slot in a specific firm occupied by a single individual. In that both jobs and occupations are but classifications themselves, they are abstractions. As Welch and MaClennan have observed ". . . if job content is defined as embracing what people do, their relations to others and what others do, and remuneration, both psychic and monetary, the logical conclusion is that no two people hold precisely the same job" (Loewenstein & Manser, 1994). The implication is that occupational descriptions function as mini-theories where they serve to structure understanding, guide predictions and facilitate control. They are neither right nor wrong, only more or less useful. Occupational descriptions like other theories hold sway for a time, eventually lose their explanatory power, and are replaced. The view of occupations as theory is a useful context for a discussion of the demand versus supply issue.

Should Occupational Grouping be Directed by Demand- or Supply-side Concepts?

Demand-side. In an economic context, demand derives its meaning from the concept of a production function---an input-output function relating the factors of labor and capital to the production of goods and services. The role of the production function as an abstraction is to model the effects of technology on the organization of work. Work in the physical sense of the expenditure of energy is the driving force of production. The distinction as to human or nonhuman capital rests on the allocation of work activities to machines or humans---a decision based upon the substitutability between or within machines and humans and the feasibility as defined by current technological constraints. At present, humans have a competitive advantage in the creative and social work activity domains. Whether machines will ever be able to perform these human work activities is a subject for philosophical debate (Penrose, 1989). Although there is a close duality between work activities and worker attributes, use of worker attributes presupposes allocation of work activities to human capital and thus ignores the possibility of interfactor substitutability (Cain, Hansen, & Weisbrod, 1967).

The concept of work requirements likewise derives its meaning within the context of a production function. Requirement is generally assumed to connote an essential condition. Without an external reference, the questions of "essential to whom?" and "for what purpose?" are unanswerable. The productive function provides this external referent and gives meaning to the notion of work requirement.

The conceptual trappings of a production function differ according to disciplines. Organizational specialists contend that work structure is dictated by organizational goals. A prime example of this position is Gottfredson's observation that ". . . an organization's goals should determine which worker performance outputs the organization requires; the outputs in turn should determine which tasks the organization will require its workers to perform; and the required tasks in turn determine the skills that workers should possess" (Gottfredson, 1994, p. 4).

With but a shift in emphasis from profit maximization/cost minimization to organizational management, the effects on the determination of work requirements are equivalent.

Supply-side. Supply is best understood in juxtaposition to demand. While demand is a derived requirement of work, supply pertains to the characteristics and behaviors of real persons. Campbell (1994) acknowledges the demand-supply dichotomy in his distinction of job tasks versus job behaviors. According to Campbell (1994), "Job tasks can be specified without reference to any specific individual job holder" (p. 19). In contrast, task behavior is defined as that individual behavior ". . . that is relevant for the organization's goals and which can be evaluated in terms of its relative degree of contribution is a reasonable definition of the term 'performance'" (Campbell, 1994, p. 19). Thus, performance is what people actually do, whereas job tasks are the required work activities to be performed. Although separate workers may be directed by the same work requirements, their individual performances may differ significantly.

Summative Conclusion. The role of demand- and supply-side concepts in occupational classifications hinges on whether work- or worker-centered variables are the more useful for classification purposes. We contend that demand-side concepts couched as work activity requirements ar the more meaningful sorting variables for SOC revision. Demand is more sensitive to changes in the production function than is supply. Supply as the stock of qualify human capital frequently lags demand due to market imperfections. To base an occupational classification system on the collective results of individual career decisions would make an occupational classification system captive to institutionalized restraints, thereby reducing its sensitivity to changing workplace requirements.

What Sorting Variables Should be Used to Define and Aggregate Occupations?

With regard to the classification principle that occupations be defined as a grouping of similar jobs, Stevens (1994) asks the rhetorical question "homogeneous with respect to what?" (p. 217). The most direct answer is similarity with respect to required work activities. Choice of work activities as sorting variables does not necessarily imply only activities defined at the task and duty level. Just as occupational groups can be defined at successively higher levels of generality, so can work activities. The concept of work activities ranging from occupation-specific through intermediate to generalized work activities defines a specificity-generality continuum. Choice of specificity level for sorting variables will determine the level of the occupational groupings produced. Work activities defined at a more specific level and used as sorting variables will produce occupational clusters at a finer level of differentiation than will sorting variables defined at a higher level of aggregation.

Summative Conclusion. Sorting variables for a revised SOC should include a carefully selected set of work activities defined at differential specificity levels. Depending upon the generality level of the occupational groupings desired, work activity sorters can be selected so as to produce occupational clusters at the desired specificity/generality level. Conceptualization of work activities according to successively higher levels of generality has a decided classificatory advantage. As the generality level of occupational groupings increases, the likelihood of technological obsolescence decreases. McCage (1994) offers the substantiating observation that "Contrary to popular belief, the tasks that workers actually perform do not change that much over time if they are properly identified and verified to start with. What does change are the materials and technology that drive the processes, not the tasks that are performed" (p. 14). At successively higher levels of generality, the effects of technological change should tend to dampen out.

How Should a Revised SOC Unit Group be Defined?

A common practice in occupational classification structure design is to designate the bottom or most fundamental grouping as the underlying unit grouping. Thus, the unit groupings represent the basic building blocks of the occupational classification structure. These unit groupings may be either single occupations or clusters of occupations. The issue in part rests upon the criteria for the identification and selection of basic occupations.

Summative Conclusion. Consistent with the considerable interest in integration of the revised SOC and the reinvented DOT, DOT occupational descriptions appear to be the most logical candidates for occupations. Although subject to some limitations, the DOT is the most comprehensive occupational information database currently available at the national level. Crosswalks exist linking DOT occupations to both the SOC and the OES. Unfortunately, OES-DOT crosswalks do not exist for the latest OES version.

Rather than use individual DOT occupations as unit groups, we recommend instead that clusters of DOT occupations constitute a unit grouping. There is considerable support for the formulation of unit clusters based on the principle of intra-cluster substitutability. The underlying principle is that there should be more substitutability within a cluster than between clusters. Cain, Hansen and Weisbrod (1967) stipulated that in order for an occupational classification system to be useful for economic purposes, "occupational classes should therefore be relatively homogeneous, in the sense that a high degree of substitutability should exist within each class" (p. 49-50). Use of substitutability as an indicator of occupational homogeneity has been affirmed by several Proceedings authors (Popkin, 1994, p. 129; Loewenstein & Manser, 1994, p. 143; Bakker, 1994, p. 181, 273).

Consequently, we recommend that DOT clusters be formulated on the basis of intra-cluster substitutability. Simultaneous clustering of all 12,000 plus DOTs would be a gargantuan endeavor with remote chance of success given current resource limitations. Therefore, we further recommend that DOT occupations be grouped a priori according to content similarity and that unit clusters be derived from a restrictive set of DOT occupations. Two options are immediately available: use the 1980 SOC-DOT crosswalks or the OES-DOT crosswalks. Either choice results in a more manageable number of DOTs that share similar content by virtue of their common membership in a parent SOC or OES grouping. Subclustering within a parent SOC or OES grouping on the basis of substitutability serves as a further screen to ensure intra-cluster similarity with resulting economic information on labor resource flexibility.

Is Retraining Time an Acceptable Proxy for Skills Substitutability?

Displacement is a disquieting result of re-engineering the American workplace. Of the ten workforce outcomes identified by Drayse, et al. (1994) as addressable by occupational information, three deal directly with issues of worker displacement (p. 54-56). These authors went on to identify helping displaced workers transfer their skills to new jobs as a major contributor to the future purpose of a revised SOC. Central to the problem of worker displacement is the notion of skills transferability and its companion concept, skills substitutability. One might argue that substitutability is a more fundamental concept than skills transferability.

Substitutability as a demand-side concept derives its meaning from the background context of a production function. Substitutability refers to both intra-factor and inter-factor equivalency. Inter-factor substitutability occurs when work activities can be performed by either human or nonhuman means. Intra-labor substitutability implies equivalency within a set of human work activities as to their interchangeability in the production function. Perfect substitutability would assume that activities were completely interchangeable with no corresponding loss of efficiency. The actual mix of production factors, however, is a complex function involving factor and product prices (Loewenstein & Manser, 1994).

At the micro-level, substitutability is determined by firm-based optimization decisions. The totality of these micro decisions are collectively reflected in occupational mobility patterns. Unfortunately, occupational mobility data is not readily available. Furthermore, even if available, mobility data reflect institutional barriers that serve to blur substitutability determination. As Bakker (1994) noted in his description of the Netherlands occupational classification system, "In principle, it is possible that between two occupations which required skills are almost the same, no actual mobility exists as gender, age or health barriers prevent that" (p. 274).

As a means of circumventing the possible biasing effects of institutional barriers such as gender, age and health, both the Netherlands and the Australian classification systems make use of the concept of **potential** mobility. The design objective of the Australian classification system is reportedly to ". . . group occupations in such a way that any given individual would have the potential to move between occupations in the same unit group without the need for significant retraining but he or she would not have the potential to move between occupations in different unit groups without some additional retraining" (Stevens, 1994, p. 230).

The Australian experience strongly suggests that retraining time is a viable proxy for skills substitutability. The relationship between skills substitutability and retraining time is inverse. The shorter the required retraining time, the greater the extent of skills substitutability. Likewise, the longer the retraining time required, the less the extent of skills substitutability. Consequently, unit occupational groupings are those that have a shorter within-group than between group retraining time.

Summative Conclusion. As a resolution of this classification issue, we contend estimated retraining time is a viable proxy for skills substitutability and should be used to define the unit occupational groups in a revised SOC. Unit groupings could be formulated by clustering DOTs nested within current occupational classifications for which comprehensive and reliable crosswalks exist. Candidate classifications systems are the 1980 SOC and the OES. By clustering according to estimated retraining times, unit groupings could be formulated that reflect homogeneity with regard to intra-cluster skills substitutability. In the clustering process, DOTs that did not seem to belong to the initial parent grouping could be identified and reclassified. The use of unit occupational groupings to create a revised SOC will be described in greater detail in Chapter V.

How Should the Total Number of SOC Unit Groups be Determined?

Determination of the total number of revised SOC unit groups is dependent upon the definition of unit groups employed. If a unit grouping is defined at the level of a DOT occupational description, then there would be some 12,000 plus unit groups. In this case, the revised SOC would assume the role of the current Occupational Group Arrangement (OGA) in the fourth edition DOT. Considering the current concern for parsimony and the unevenness of DOT coverage across the occupational spectrum, having over 12,000 unit groups in a revised SOC would be counterproductive.

Using the unit groups of the 1980 SOC or modifications thereof represents another option. In the absence of linkage between a revised SOC unit grouping and the DOT codes corresponding to that grouping, a revised SOC will not be able to integrate with the DOT as an occupational information database. This would represent a serious lost opportunity cost, and would thwart integration with the DOT as advocated by APDOT (1993) and numerous conference authors and discussants (Drayse et al., 1994; Silver, 1994; Rosenthal, 1994; Dye, 1994; Stevens, 1994; Uhalde, 1994; & Plewes, 1994).

An option more facilitative of SOC-DOT integration is to define the revised SOC unit groups as subsets of DOT occupations. These clusters would serve as the linchpin for integrating the two systems. DOT occupational codes currently assigned to either 1980 SOC unit groupings or five-digit OES details via existing crosswalks could serve as stratification levels. Each stratification level could be regarded as a subpopulation of DOT occupations with constrained technological content variability due to common membership in the same SOC or OES occupational grouping. As previously discussed, clustering of DOTs within a given occupational grouping using retraining time as a proxy for skills substitutability could create unit occupational groupings with relatively homogeneous potential substitutability.

Based upon previous clustering experience, it is estimated that each OES five-digit code will produce about 1.5 clusters on the average. If OES five-digit codes were used as the parent cluster and given that the current OES has some 750 groupings at the occupational detail level, one should expect that the number of unit groupings to be somewhere between 1200-1400. This would represent a significant collapsing of detail from the more than 12,000 DOT descriptions in the fourth edition.

To What Extent Should Industrial Detail be Incorporated Into an Occupational Classification System? Should Supervisors be Classified Separately From Workers They Supervise? Should Apprentices and Trainees be Classified in the Occupation for Which They are Trained?

In the current SOC, these issues are resolved a priori by incorporation as classification principles. Classification principles serve as guidelines for the development of an occupational classification structure by rationale means. Classification construction starts at the highest level of generality, frequently indicated by division, and proceeds to create successively lower divisions by a sequence of splitting decisions. Other than the global classification principles, criterion guiding classification decisions are tacit and remain largely uncommunicated.

The role of classification principles changes markedly when numerical taxonomic procedures are used. Cluster structure is dependent upon the sorting variables used and the clustering procedures employed. Given a choice of variables and methods, the cluster structure is a function of the similarity/dissimilarity of the profiles of sorting variables across the occupations to be clustered. How the clusters will be defined is an empirical question.

Answers to the above related issues depend in large part upon the nature of the sorting variables used. If work activities as sorting variables reveal that technological content at the division level varies by industry, then industrial detail will play a part. As opposed to a rational taxonomic approach, the extent to which highly aggregated technological content differs by industry cannot be ascertained prior to performing the actual cluster analysis. The issues pertaining to the classification of supervisors and supervisees and apprentices and trainees very likely are sensitive to skill level differences. To the extent that skill levels intervene to differentiate supervisors from those supervised, they will be separated in the classification. Of course, empirical results can always be subjected to rational scrutiny and minor modifications made to enhance overall meaningfulness.

Should Employment Size be the Sole Reason for Inclusion or Exclusion of an Occupational Group?

Employment size in a unit group is of concern to the extent that if too low reliable employment estimates cannot be obtained. Therefore, in the construction of occupational classification systems for statistical usage, estimated employment by unit group is a frequently used criterion for unit group inclusion. In order to obtain acceptable employment size, unit groups may be merged or employment data collected at the higher minor group level.

Availability of employment data at the unit cluster level presents a potential problem. Currently, employment data is collected at the five-digit OES level. Unit clusters are proposed to be identified as subgroupings of the occupations assigned to a five-digit OES. Thus no employment data would be available at the unit cluster level unless means were determined to disaggregate the estimates to these levels or to allocate five-digit OES employment estimates according to statistical methods.

Codeability is another criterion frequently used to assess the operational utility of derived unit groupings. Unit group codeability could be improved by the provision of unit cluster definitions which would be a composite of the member DOT duty and tasks statements. Composite cluster definitions are prime examples of the supplementary information that could be provided in an integrated SOC-DOT system. Additional details will be provided in Chapter VI.

Linkage to Other Systems

The meaning of linkage depends upon the extent to which the revised SOC becomes a true occupational classification standard. If standard is rigorously interpreted and enforced as meaning uniformly applicable across all users of occupational information, then linkage can be interpreted as integration of system components to create a comprehensive occupational information network. If a revised SOC is published as suggested guidelines with no corresponding administrative and regulative procedures to ensure that it is a standard in more than name only, linkage will translate into crosswalking between existing systems. The following issues are offered as a means of more fully exploring the ramifications of the action alternatives.

Should any Future Version of the DOT be Assembled at the SOC Level?

The APDOT in its final report to the Secretary of Labor regarding reinventing the DOT as an occupational database for the twenty-first century offered eighteen specific recommendations (APDOT, 1993). Recommendation number three spoke to the need for the DOT to be reorganized according to a single standardized occupational classification system that would allow occupational and labor market information to be structurally compatible. The Department of Labor was recommended to consider carefully the upcoming SOC revision as a possible integrative framework. In recommendation number seventeen, APDOT specifically recommended that the DOT play a foundation role in the proposed SOC revision.

The conceptual and technical roles of a revised SOC in the transformation of the DOT from dictionary to database have been previously discussed. The complementary side of how the DOT can augment the utility of a revised SOC warrants consideration. Considered independently, the SOC functions primarily to support occupational classification and coding as used in the collection and reporting of statistical data. Without the augmentation provided by supplementary occupational data, the SOC is a sparse source for the support of workforce development needs. The DOT alone lacks the integrative and definitional shaping force provided by a truly standard occupational classification system and, if deprived of this capability, will fail to serve as a foundation of a comprehensive occupational information network.

Assemble the reinvented DOT according to the structure of a newly revised SOC and a win-win situation emerges. Supplementing the SOC with the richness of occupational detail as described by the APDOT Content Model enhances its utility for public and private programmatic purposes and offers a rationale for its usage that transcends mere compliance with federal reporting requirements. Collection, presentation and dissemination of DOT Content Model data at differential levels of the SOC taxonomy has the potential for becoming the well-conceived "system" as envisioned by Cain, Hansen & Weisbrod (1967).

Summative Conclusion. A major issue is not whether the SOC and DOT should be integrated, but rather how this integration may take place. Definition of unit groupings in a revised SOC as clusters of DOT occupations homogeneous with respect to retraining time operationalizes the enfolding of the two systems. In this manner, integration occurs at the most fundamental level of the occupational classification taxonomy.

The intermeshing of the two systems should not be confined to the unit groupings but should occur at all taxonomic levels. DOT Content Model occupational information should be graduated by level of generality to correspond with the taxonomic level at which it is provided. Minor group occupational information should be more general than unit group information, and the generality level should increase from minor to major to divisional levels. Graduation of occupational informational detail raises questions as to what is meant by level of detail. For quantitative data, leveling can be accomplished by simple summations or averaging. For most of the qualitative occupational information, composite rather than aggregate data will have to be provided. Given this approach, SOC-DOT integration will be accomplished at all taxonomic levels. This approach differs from that advocated by Stevens (1994) in that differentially detailed supplementary information would be provided at all levels rather than only for tier one occupations as he proposed. Decisions as to the scope of Content Model information to be provided at each taxonomic level and the criteria to guide taxonomic leveling of supplemental occupational information remain to be resolved during the developmental stage. Additional framework details will be provided in Chapter VI.

Should the Revised SOC Continue to Rely on Crosswalks to Link Various Occupational Classification Systems?

Crosswalks are a necessary expedient in the absence of a standardized and uniformly applied occupational classification system. Implementation of a revised SOC with enforced usage by major governmental core users would obviate the need for crosswalks between interagency systems. The need for crosswalking with peripheral systems remains. Crosswalking the SOC with major training programs and resources is and will continue to be required. Revising the SOC will necessitate that current crosswalks be updated. The NOIC/SOIC network is well situated to play a major role in the crosswalk revision activities.

The role of crosswalking a SOC-DOT occupational database to private sector systems is a challenging and critical aspect of workforce development. Without the capabilities to link to a national occupational information database, the extraordinary potential of a truly integrated system will be lost. Employers must ultimately realize a benefit from the informational partnership. The achievement of this purpose should be the major agenda of a revised SOC-DOT initiative.

What is the Need for Uniformity and Consistency Across Various Classification Systems?

Uniformity and consistency of use are the hallmarks of a standardized occupational classification system. Benefits for core producers and users have been well expounded and will not be repeated. The benefits for a wider sphere of users and usages merit further discussion. The development of a standardized national system of voluntary skills standards now the legislative mandate of the National Skill Standard Board would seem to be an immediate beneficiary. The development and implementation of a standardized skill standards system in the absence of linkages to a standardized occupational classification system appears to be a contradiction of national goals. Standardized skills are critically important occupational information that should be a component of an occupational database organized and assembled according to the SOC structure. A revised SOC with numeric occupational clusters arrayed at different levels of analysis could provide a generic cluster structure capable of supporting skill standards development (Pearlman, 1994). Use of a common occupational database to support inter- and intra-agency initiatives would be a major step toward the achievability of a truly comprehensive and integrated occupational information system.

What Roles Should Compatibility With ISCO Play in Restructuring the SOC?

International compatibility raises an interesting set of related issues. If the SOC is constructed to represent the structure of the U.S. economy, then its uniqueness follows as a consequence, unless one assumes that all developed countries in the world are moving toward an economic structural omega. The advisability of international structural equivalency notwithstanding, patterning the SOC after the ISCO acknowledges the ISCO as an international benchmark. Wootton (1994) summarizes the argument by concluding that ". . . although internationally-comparable occupational detail would be desirable, ISCO-88, as it is currently structured does not provide sufficient added value to compensate for the value lost in nation-specific detail" (p. 332).

Reluctance to use the ISCO as a design prototype does not preclude the possibility of linkage with a revised SOC. SOC-ISCO linkages could be accomplished through the use of appropriately designed crosswalks. The capability to link the domestic structure to that of other countries should be of interest to multi-national corporations. The wider the sphere of potential usages, the greater the likelihood of developing a network of supportive stakeholders.

III. CLASSIFICATION PRINCIPLES

This chapter presents the principles of classification that guide our proposed framework for SOC revision as described in subsequent chapters. These principles are similar in intent to the twelve classification principles of the 1980 SOC. They serve to convey the underlying rationale of framework development, communicate the purpose and intent, and differentiate the broad areas of framework coverage. These principles differ from those of the 1980 SOC in that they address structural rather than substantive classification concerns. The fundamental differences are derived from the distinction between the rational and empirical approach to classification design. Each principle is stated as a design imperative. Principles are intentionally stated in a broad context so as to underscore their macro-influence upon subsequent framework design considerations.

The Classification Should be Based on Work Activity Requirements

Work activity requirements are succinct statements generally consisting of an action verb and an object acted upon. These activity statements are descriptive of work required in the production of goods and services. In the sense that they denote production function requirement, work activities are considered to be demand based. The important consideration to note is that these statements pertain to work required to be accomplished as distinguished from the acquired characteristics of people viewed from a supply-side perspective.

Work activity requirements should be sufficiently comprehensive so as to be descriptively applicable to all work performed in the civilian sector of the U.S. economy. The implication intended is that all work should be potentially describable by a manageable number of appropriately crafted work activity statements. Description of the work domain with a carefully chosen set of activity descriptors is to be conceptually differentiated from a dictionary approach to work with its myriad of situational and contextually specific details.

Work activity requirements should be developed to span the occupational specificity-generality continuum. Work activity requirements should range from those descriptive of the specific unit occupational groupings through intermediate and general levels and finally to the more foundational work activities that cross broad occupational content groupings. The important consideration is that work activities can be defined at higher levels of generality with implications for broader levels of classification granularity.

The Classification Should be Structured According to Skill Level and Skill Specialization

Unit occupational groupings should be arrayed into a matrix structure, where skill levels are the rows and skill specialization the columns. To create this matrix arrangement, unit occupational groupings should be identified and clustered into twenty to thirty major content groupings according to similarities of work activity requirements. These major groupings would represent a first approximation to the divisional structure of a revised SOC. This prototypic divisional structure should be evaluated and revised as necessary to create a meaningful divisional classification.

Once these major divisional groupings have been established, the member unit groupings of each divisional cluster could be assigned to a specific skill level. This assignment could be construed as the occupational analogue to job evaluation. Occupational groupings could be assessed according to factor scores and the assignment made to skill levels using decision models that would minimize classification error. In this manner, a skill level by content specialization matrix could be induced. Cells in the resulting matrix would contain unit occupational groups in a specific division and skill level. These cells could operationally be defined as constituting the major groupings of the revised SOC. Further differentiation within nonempty matrix cells would produce the minor groupings of the proposed classification structure. By this procedure, all unit, minor and major groupings would be assigned a unique skill level.

The Classification Should be Created by Numerical Taxonomic Methods

The classification structure for the revised SOC should be created using numerical taxonomic methods. Occupational unit groupings should be clustered in a bottoms-up manner according to similarities of work activity requirements. Unit groupings should be clustered to form minor groupings and minor groupings merged at a higher level to create major unit groupings. In order to create the skill level by content matrix, a two-stage cluster procedure is envisioned. In the first stage of the numerical clustering, unit occupational groups would be clustered into major technological content divisions. To sharpen the differentiation within divisional classifications, division-specific work activities would be introduced and used in the second-stage clustering. Unit occupational groupings would be evaluated and assigned to skill levels. Within each skill level and division, a second-stage clustering would be performed to establish the minor groupings.

Numeric taxonomic methods should be utilized so as to allow inclusion of a sufficient number of work activity requirements required to make meaningful content differentiations. Three to five hundred work activity requirements are anticipated to be required to produce a meaningful cluster structure. This number of sorter variables, while well within modern computing limitations, exceeds the capability of the human mind to deal with in a rational manner. Human judgment is best utilized in an evaluative modality to assess the meaningfulness of the numerically derived cluster structure and to make such adjustments as are necessary to improve cluster interpretation.

The Classification Should be Hierarchical With Unit Occupational Groupings Defined as Clusters of DOT Occupations Homogeneous With Respect to Activity Requirements Substitutability

The classification should be hierarchical with unit occupational groupings as the most fundamental classification unit. Unit groupings should be clustered according to similarity of work activity requirements. Resultant second-level clusters would correspond to minor groupings which would be subsumed under major groupings. Major groupings would, in turn, be subsumed under divisional groups.

Although the system structure would be hierarchical, the proposed clustering procedure is not strictly hierarchical. What is proposed is a two-stage clustering procedure, where the first clustering is used to identify divisional groupings. Occupational unit groupings would then be leveled by skill categories, thereby creating a skill-by-content matrix with divisions constituting the columns and skill levels the rows. Second-stage clustering would be applied to each cell in the skill level by content matrix to create minor groupings, major groupings having already been achieved by the assignment of unit groupings to skill classes.

Unit groupings should be a priori constituted as clusters of DOT occupations with high intra-cluster substitutability. Skill substitutability should be operationalized as retraining time and unit clusters formulated on the criterion of less retraining within than between clusters. Once unit occupational groupings have been formed, these clusters would then constitute the building blocks of a revised SOC. In this manner, SOC-DOT integration would be achieved at the lowest classification level. Moreover, DOT 9-digit occupations would be retained under the unit groupings, thereby providing a crosswalk from the 4th edition DOT to the revised SOC.

The Classification Should be Used to Structure the Collection, Presentation and Dissemination of Occupational Data in a Reinvented DOT

The classification should provide the structural integrity for a reinvented DOT occupational database. The implication is that DOT descriptive occupational data should be organized and presented in accordance with the SOC structural categorizations. Occupational data as generally described by the APDOT Content Model should be provided for all unit occupational groupings. Consistent with this principle, selected occupational data should be presented at each subsequent level of the classification hierarchy, i.e., minor group, major group and division. Presentation of occupational data at subsequently higher levels of generality will require that occupational data be defined at correspondingly increasing levels of generality. For qualitative occupational data, this will require the synthesis of data at lower levels into composites suitable for higher levels. Quantitative data can be aggregated and measures of central tendency and variability used at higher generality levels. Used in this manner, a symbiotic SOC-DOT bond could be created. The SOC would provide the organizational structure and the DOT the content substance. United they would create the occupational database for the twenty-first century.

The Classification Should be Directly Linkable to Private Sector Skills Standardization and Certification Efforts

The revised SOC should play a coordinative and integrative role in the ongoing skill standardization and certification initiatives. The classification should provide the definitional and structural framework for skill standards determination. Classification should be so designed as to be readily linkable with the private sector at the firm level. Integration of public and private classification efforts would be a major milestone toward the development of a world class workforce.

IV. CONCEPTUAL AND METHODOLOGICAL APPROACHES

This chapter lays out the conceptual and contextual background for subsequent framework development. The first section deals with the concepts and terminology that constitute the syntax of modern occupational analysis. Conceptual and terminological coverage has been subdivided into those that pertain to worker characteristics and those that pertain to occupational characteristics. The dichotomous division of characteristics into those pertaining to workers and those pertaining to occupations parallel the distinction between demand-side and supply-side concepts. In our proposed lexicon, worker characteristics are equated with supply-side concepts and occupational characteristics with demand-side concepts. As our definitions denote, worker characteristics are properties of individual persons whereas occupational characteristics represent defined work activities. In practice, the connotative meanings tend to overlap. To the extent that worker characteristics come to be defined as work requirements rather than behavioral descriptions, worker attributes take on demand-side properties. In order to avoid semantic ambiguity, we shall strive to refer consistently to worker characteristics within the supply-side context. We begin the definitional coverage with a consideration of worker characteristics in deference to the ordering of the APDOT Content Model.

The second section deals with the two major approaches to occupational groupings---rational and numerical. The advantages and disadvantages of each method are compared and contrasted. As will be the case throughout the remaining chapters, we will conclude each methodological comparative analysis with a statement of preferred choice and a rationale for our selection.

Terminology: Concepts and Definitions

The following definitions are written within the general framework formulated by the Advisory Panel for the Dictionary of Occupational Titles (APDOT, 1993). They are adapted from definitions presented in previous papers (Cunningham, 1994; Cunningham & Wilson, 1993). Of necessity, they are somewhat arbitrary. We shall propose that work-related human characteristics and occupational characteristics are simply two sides of the same coin, supply and demand, and that both can be defined in terms of activity descriptions.

Worker Characteristics

The APDOT model contains a taxonomy of work-related human characteristics, including capabilities and personality attributes. In this paper, we shall emphasize the capability domain. From our perspective, human capabilities can be viewed as supply variables.

Conceptually, human capabilities are defined as relatively stable internal states (potentials) of the organism that enable the individual to carry out tasks. Operationally, capabilities are defined in terms of the individual's levels of performance on specified classes of tasks (Ferguson, 1956; Cunningham, 1971). In that regard, Carroll (1993) states that "...ability refers to the possible variations over individuals in the liminal levels of task difficulty (or in derived measurements based on such liminal levels) at which, on any given occasion in which all conditions appear favorable, individuals perform successfully on a defined class of tasks" (p. 8). The tasks can be contained in tests, work samples, jobs, etc. Tests with substantial intercorrelations, or substantial loadings on the same factor, are assumed to measure the same capability.

The terms "knowledge" and "skill" appear frequently in the literature on work-related capabilities. The term knowledge usually refers to some specified "body of understood information possessed by an individual..." that he/she can recall under appropriate circumstances; "more complex knowledge is called `comprehension' or `understanding' (which includes awareness of relations, meanings, etc.)" (English & English, 1958, p. 284). The term skill is more difficult to define, because it has acquired more than one meaning. By narrow definition, a skill is an "ability to perform complex motor acts..." (English & English, 1958, p. 505). By broader definition, however, "skill" refers to "...level of proficiency on a specific task or...group of tasks" (Fleishman, 1967a). Consistent with Fleishman's definition and the APDOT model, we shall define skill in the broader sense, as a developed proficiency or competence to perform a specified class of tasks, either physical or mental (e.g., typing, driving, writing, drafting, bargaining, etc.; Cunningham, 1971). Operationally, "knowledge" can be defined in terms of specified information content and "skill" in terms of specified activities. In exercising a complex skill, the individual draws on knowledge as well as other attributes. In offering the following definitions, we shall not differentiate between "knowledge" and "skill," because in occupational analysis the two are usually confounded in work activity descriptions.

The following defined capabilities mark levels in a developmental hierarchy starting with the basic and general and progressing to the more numerous, content specific, and complex. The capabilities presented early in the hierarchy are assumed prerequisites to those presented later (cf. Gagne, 1962).

Sensory Capacities. The basic sensing capabilities such as near visual acuity, far visual acuity, depth perception, accommodation, color vision, auditory acuity, kinesthesis, equilibrium, tactual discrimination, taste discrimination, and olfactory discrimination. Some of these capacities are included in job analyses carried out by the USES Occupational Analysis Field Centers (OAFCs; U. S. Department of Labor, 1991).

Physical and Sensorimotor Capabilities. These have been factor analytically investigated by Fleishman (1964, 1967b; Fleishman & Quaintance, 1984) and are comprehensively defined in the Fleishman Job Analysis Survey (FJAS; Fleishman & Reilly, 1992), a rigorously developed and widely used ability-requirement inventory (Fleishman & Mumford, 1988). Among them are such capabilities as control precision, multilimb coordination, reaction time, arm-hand steadiness, manual dexterity, finger dexterity, static strength, dynamic strength, and gross body equilibrium. Some of the sensorimotor capabilities are measured by the General Aptitude Test Battery (GATB; U. S. Department of Labor, 1970), and others are reflected in the Physical

Demands Factors in the USES's Handbook for Analyzing Jobs (U. S. Department of Labor, 1991). Most of the FJAS sensorimotor capabilities are included in a recently initiated R and D project being carried out under the aegis of the U. S. Department of Labor by a consortium of organizations including the American Institutes for Research, Personnel Decisions Research Institutes, Inc., Management Research Institute, Jeanneret & Associates, Inc., Westat, Inc., and Policy Studies Associates, Inc. This project, directed toward ultimate replacement of the current Dictionary of Occupational Titles (DOT) involves development of a prototype automated Occupational Information Network (O*NET) under the APDOT model.

Basic Mental (or Cognitive) Abilities. These are measured by standardized tests such as the GATB and the Differential Aptitude Tests (Bennett, Seashore, & Wesman, 1966). Different cognitive abilities have been rather comprehensively identified by French, Ekstrom, and Price (1963), and include such factors as verbal comprehension, number facility, spatial visualization, memory, inductive reasoning, perceptual speed, closure, and ideational fluency. A number of the French et al. factors are defined in the Fleishman Job Analysis Survey (FJAS; Fleishman & Reilly, 1992), which in turn has contributed descriptors to the previously mentioned O*NET project. Recently, Carroll (1993) has reported on extensive factor analytic research, based on which he posits eight broad second-order cognitive factors subsuming more specific cognitive abilities.

Basic Skills. The APDOT Content Model defines Workplace Basic Skills as "[f]undamental developed abilities that are required to at least some degree in virtually all jobs" (APDOT, 1993, p. 33). It offers as examples "reading, writing and arithmetic or computational abilities." This is similar to the definition offered by English and English (1958) for "basic skills": "those activities learned in school...esp., the mechanics of reading, spelling, writing, and the primary processes of arithmetic"; "[t]hese skills are...deemed fundamental for practical life..." (p. 60). Thus, these capabilities might be considered basic educational skills. The O*NET project has identified such basic skills as Reading Comprehension, Writing, Speaking, Mathematics, and Critical Thinking.

Cross-Functional Skills. "The various types of developed generic skills that are related to the performance of broad categories of work activity that tend to occur across relatively wide ranges of jobs....Examples include: information gathering, oral communication, problem analysis, negotiating, organizing and planning, coordinating with others and coaching or mentoring" (APDOT, 1993, p. 33). These skills are generalizable, trainable, and relatively free of detailed job or technological content. The activities reflecting them could be characterized as "worker oriented" if applied to job description. They include social skills, communication skills, problem solving skills, etc. This category would encompass many of the "fundamental skills" identified by the SCANS Commission (1991) and "generic skills" as defined by Employment and Immigration Canada (Smith, 1974). The O*NET project includes such cross-functional skills as Persuasion, Service Orientation, Problem Identification, Information Organization, Judgment and Decision Making, Idea Evaluation, Time Management, Management of Material Resources, and Implementation Planning. Also included in the O*NET are some technologically oriented skills such as Installation, Operate and Control (equipment and systems), Troubleshoot, and Repair.

Some of these latter, technologically oriented, skills might be subsumed under our next category, General Occupational Knowledges and Skills.

Occupational Knowledges and Skills (KSs). The APDOT Content Model defines "Occupation-Specific Skill" as: "The developed ability to perform given general or specific work activities that tend to occur across relatively narrower ranges of jobs and/or are defined in relatively job or activity specific terms; these are operationally defined as the ability to perform...generalized work activities and job duties/tasks...." (APDOT, 1993, p. 33). "Occupation-Specific Knowledge" is defined as "[u]nderstanding or awareness of, or techniques related to a particular subject area, discipline, trade, science, or art" (p. 33). Thus, the Occupational KSs are "job-oriented" or technological in content, whereas the preceding definitions addressed more basic "foundation" capabilities of a "worker-oriented" nature. Because this definition spans a rather broad range on a content specificity-generality continuum, it might prove worthwhile to subdivide that dimension. As mentioned, we shall not attempt to separate knowledges from skills, because they are usually confounded in work-activity descriptions.

(1) General Occupational KSs (GOKSs): Altman and Gagne (1966) have defined "general vocational capabilities" as "skills and/or knowledges having relevance to a variety of occupations which go beyond the basic academic tools of reading, writing, arithmetic, and understanding general science" (pp. 5-6). This is the definition we shall adopt for GOKSs; we have simply modified the title. Altman and Gagne operationally defined this concept in a battery of tests falling into six major categories along a hardware-to-people continuum. Although Altman and Gagne's GOKSs probably overlap Cross-Functional Skills as defined above, they are more technologically specific than most Cross-Functional Skills. Following are possible examples of GOKS content (from Altman and Gagne, 1966; Cunningham et al., 1971): common hand tools, common power equipment, mechanical principles, vehicular operation, scaling and measuring, electrical principles, common electro-mechanical devices, drawing tools and procedures, structural components, first aid practices, sterilization, tables and graphs, letter and report writing, computer usage, office routines, filing, contracts, persuasion and sales procedures, rules of effective service, social etiquette and job conventions, and supervision. As mentioned previously, some of the technologically oriented Cross-Functional Skills from the O*NET project might, instead, be classified as GOKSs. In addition, some of the O*NET prototype Knowledges, might contribute to this category; e.g., Mechanical, Money, Safety/Security, Sales/Marketing, Sanitation/Cleaning, Computers, and Clerical.

(2) Cluster KSs (CKSs): CKSs are generalizable within defined occupational groups or clusters. Just as occupational clusters may vary in their breadth or inclusiveness, the CKSs representing intracluster similarities and differences will vary in their degree of specificity or generality. For example, CKSs applicable across occupations within SOC major group 67 (Mechanics and Repairers) would be more general than CKSs applicable only within SOC minor group 671 (Vehicle and Mobile Equipment Mechanics and Repairers), which in turn would be more general than CKSs specific to SOC unit group 6711 (Automobile Mechanics). Another

example would be the progression down an OES hierarchy from code 32000 (Health Practitioners, Technologists, Technicians), to code 32100 (Health Diagnosing and Treating Practitioners), to code 32102 (Physicians and Surgeons). The more general CKSs applicable at an upper level in a clustering hierarchy can be used to form and characterize narrower clusters at a lower level in the hierarchy, but more fine-grained CKSs are then needed to further describe and subdivide those lower-level clusters. As mentioned earlier, human capabilities are manifested in activities. Thus, it is proposed that CKSs can be represented in generalized work activity statements (descriptions) appropriate to the scope and content of their particular occupational clusters. Just as the GOKSs' distribution on a specificity-generality continuum overlaps somewhat that of Cross-Functional Skills, the CKSs could be expected to overlap with GOKSs. These definitions are modal rather than absolute or mutually exclusive.

(3) Occupation-Specific KSs (OSKSs): OSKSs are specific to occupations at the level of defined titles in the Dictionary of Occupational Titles. (The term "occupation" is defined in the next section, Occupational Characteristics, where it is noted that an occupation is also a cluster.) CKSs are applicable but not sufficient in characterizing individual occupations. The content of OSKSs is reflected in the general task/duty statements applicable to occupational titles. For the purpose at hand, however, OSKSs are of less interest than GOKSs and CKSs because of their limited usefulness in forming and/or characterizing broader categories in an occupational classification system.

Other Personal Qualities. The APDOT Model defines "Personal Qualities" as "[a]n individual's characteristic, habitual, or typical manner of thinking, feeling, behaving, or responding with respect to oneself, others, situations, or events" (APDOT, 1993, p. 33). This is similar to English and English's (1958) definitions of "personality" and "personality trait." Ferguson (1956) has posited that the "[c]haracteristics of personality, attitudes, and the like can be viewed as attributes of behavior which have attained some stability through a lengthy learning process" (p. 127). Cunningham (1971) proposed, for example, that "attributes such as interests, needs, and attitudes might be conceived as [learned] tendencies to approach or avoid specified classes of tasks, conditions, or outcomes--i.e., as approach-avoidance dimensions" (p. 18). More specifically, work-related interests, a common construct in vocational and counseling psychology, could be viewed as preferences for (tendencies to approach or avoid) specified classes of work activities (tasks), and work-related needs as preferences for more general classes of work benefits, opportunities, outcomes, conditions, etc. (Cunningham, 1988). Similarly, "values" might be viewed as positive or negative dispositions toward very broadly defined classes of behaviors, outcomes, conditions, and concepts; and work-related "self-esteem," if broken into self-efficacy components, as one's self-assessed capability to perform specified classes of tasks and accomplish specified objectives. All of these constructs might be subsumed under the broad heading, "Occupational Self-Concept" (Augustin, 1983).

The point, of course, is that as in the case with human capabilities, many personality constructs can be described in terms of observable activities and conditions. The USES has developed 12 interest scales based on factor analytic research, representing various work activity domains such as Artistic, Scientific, Mechanical, Business Detail, Humanitarian, and Leading-Influencing (Droege & Hawk, 1977; U. S. Department of Labor, 1979). In factor analytic and multitrait-multimethod analyses carried out at N. C. State (Spetz, 1987; Spetz & Cunningham, 1989), the six forenamed USES scales converged nicely on Holland's six work-related personality dimensions as measured by the Self-Directed Search (Holland, 1973, 1985). The 12 USES interest dimensions have been incorporated into the agency's job analysis system. In addition, the O*NET project has recently addressed work-related needs as represented in the Minnesota Importance and Job Description Questionnaires (MIQ and MJDQ; Dawis & Lofquist, 1984), directed toward such job benefit/opportunity factors as pay, security, working conditions, variety, advancement, recognition, autonomy, and ability utilization. The MIQ and MJDQ have been rigorously researched (Dawis & Lofquist, 1984); in some recent factor analytic and multitrait-multimethod analyses at N. C. State, we found substantial support for the MIQ's construct validity (Cunningham, Knoeller, Carter, & Pike, 1991; Pike, 1993). Personality constructs, although useful in the context of person-job matching, will probably be less relevant than capabilities in the development and description of a skills oriented occupational classification system. They do, however, merit serious consideration on the supply side of the equation.

Occupational Characteristics

As noted, the preceding constructs define what people supply to the workplace. Job and occupational characteristics, on the other hand, represent what the workplace demands of people, its human requirements. Although conceptually worker characteristics are inferred internal states of the organism, operationally they can be described in terms of concrete behaviors or activities. Correspondingly, we propose that occupational requirements be characterized in terms of work activities rather than worker attributes. Compared to human attribute definitions, work activity statements are less abstract, easier to understand and envision, and require less inference when used as job or occupational descriptors. Later in this paper, we shall attempt to show how conventionally defined human attributes can be either linked to or directly represented by work activity statements, supplemented by related descriptions of information (subject matter) content, tools/machines/equipment used, and objects/materials acted upon.

With few exceptions (e.g., generalized work activities), the following definitions conform to established usage in occupational analysis, dating back to the writing of Carroll Shartle (1946).

Task. A discrete unit of work, with an identifiable beginning and end, directed toward a specific meaningful goal (McCormick, 1979a). "Tasks are collections of activities that are directed toward the achievement of specific job objectives" (Levine, 1983, p. 3). According to Altman and Gagne (1966), "...the task is...the smallest part of a job having a meaningful unitary goal or purpose" (p. 21). It has been legitimately noted that "task" is a relative concept; an activity constituting a task in one job might be considered a task element in another job. For example, "Slices cold meats and cheese by hand or machine" would be a task in the job of Sandwich Maker but only a task element in the job of Short Order Cook, in which "Prepares sandwiches" would be a task rather than an entire job (U. S. Department of Labor, 1991, p. 2-1). Similar caveats regarding relativity apply to all subsequent definitions as well. Following are examples of task statements: "Performs Automatic Transmission Pressure and Stall Tests" (Israelski, 1988); "Schedule appointments over the phone" (Drauden, 1988); "Clean dental instruments" (Christal & Weissmuller, 1988); "Sort or route multiple copies for forms" (Gandy, 1988); "Communicates with clients by letter or telephone in order to gather information for tax returns" (Levine, 1983); "Code business application programs" (for software jobs; Page & Caskey, 1988).

Duty. A larger segment of work consisting of several related tasks, an aggregation of tasks; "...a collection of tasks all directed at general goals of a job" (Levine, 1983, p. 3). Examples of duty statements: "maintaining and repairing [automobile] transmissions...supervising data systems analysis and design...performing mailroom activities" (McCormick, 1979a); "Preparation of Tax Returns (Levine, 1983); "Perform System Design....Develop Programs" (for software jobs; Page & Caskey, 1988). Duties are manifestations of the previously defined Occupation-Specific KSs.

Generalized Work Activity (GWA). A more general activity statement applicable across a range of jobs and occupations. The APDOT defined "Generalized Work Behaviors" as "aggregations of similar occupation-specific skills into broad activity statements"; "Generalized work behaviors do not include highly occupation-specific content, and they tend to occur across substantial numbers of different occupations" (p. 12). Examples of generalized work behaviors offered by the APDOT include: "writing reports, reading blueprints, preparing budgets, and repairing electrical appliances" (p. 13). Previous work under this rubric had included such statements as "Interprets and explains rules and procedures to individual members of the public" (Outerbridge, 1981) and "Drafts regulations based on an analysis of information" (O'Leary, Rheinstein, & McCauley, 1989). Most recently, under the O*NET project, P. R. Jeanneret and W. C. Borman have identified 28 Generalized Work Activities from previous factor analytic research, including such factors as: "Repairing, Maintaining or Adjusting Devices/Equipment (Mechanical)...Using Information Sources...Identifying Objects, Actions, Events...Inspecting Equipment, Devices, etc....Analyzing Data and Other Information...Organizing and Planning...Operating Vehicles and Mechanized Devices/Equipment...Performing Physical Activities Requiring General Body Movements...Selling/Influencing Others...Negotiating...Coordinating Others." As can be seen, the descriptors generated under the heading "General Work Behaviors" or "Generalized Work Activities" span a rather broad range on a specificity-generality continuum. Accordingly, it might prove useful to subdivide this continuum into narrower categories. As with the capability definitions, the distinctions between these categories are relative and rather blurry; the category definitions are simply modal approximations. In addition to explicit activity statements, our definition of GWAs includes descriptions of closely related factors such as different kinds of information and tools/machines/equipment used as well as objects/materials acted upon. The following categorical breakdown is based on level of generality, but not necessarily on successive aggregation. Although our first two categories (Area Work Activity and Intermediate Work

Activity) represent levels of aggregation, our third category (Foundation Work Activity) does not.

(1) Area Work Activity (AWA): A GWA that is limited to a particular content area--such as Health Care (OES code 32000) or Mechanical/Electrical/Electronic Equipment Installation and Repair (SOC division 17)--but is more general than a typical duty statement. AWAs correspond roughly to the previously defined Cluster KSs. To our knowledge, this concept has not been developed, so we can only offer some crude hypothetical examples. The envisioned purpose of AWAs is to supplement the more general descriptors defined below (i.e., IWAs and MWAs) in determining similarities and differences among occupations within specified content areas. Possible examples of AWAs under Health Care might include: examine patients; evaluate diagnostic tests; perform surgery; give medications and treatments to patients as prescribed; sterilize instruments; oversee activities in a medical unit or facility. Possible examples of AWAs under Mechanical/Electrical/Electronic Equipment Installation and Repair: install manufacturing machinery; rebuild small internal combustion engines; diagnose engine malfunctions in road vehicles or mobile equipment; service electrical appliances; troubleshoot and repair electronic equipment; repair bodies and structural components in transportation and mobile equipment. At the minor group level under this SOC division, the Vocational Technical Education Consortium of States (V-TECS) has identified "duties or functions" for Industrial Maintenance Mechanics (Krogstad & Dawson, 1981). Some of these functions, induced from job-task inventory analysis, appear broad enough to qualify as AWAs, for example: "Assembling and Disassembling Machine Mechanisms...Installing and Removing Machinery...Performing Electrical Operations...Performing Welding Operations...Working Metal with Hand or Portable Tools...Supervising Maintenance and Repair Functions." V-TECS has compiled a substantial bank of such functions for different occupational groups, along with listings and descriptions of their constituent tasks, addressing over 700 titles in the DOT (McCage, 1994). This should be a useful source of AWAs. Useful AWAs might also be obtained from the MOSAIC (Multipurpose Occupational Systems Analysis Inventory--Closed Ended) system developed by the U. S. Office of Personnel Management (1991) for supervision and administration. In addition to activity statements such as those in the foregoing examples, AWA-level descriptors might include statements of information or subject matter content, tools/machines/equipment used, and objects/materials acted upon.

(2) Intermediate Work Activity (IWA): The IWA is the next step up in generality from the AWA and is applicable to a wider range of occupations, although like the AWA, it is job-oriented or technological in content. It often applies to more than one content area but does not cut across the broad occupational spectrum. IWAs correspond approximately to the previously defined General Occupational KSs and perhaps some of the more general cluster KSs; however, descriptors falling into the IWA category vary substantially in terms of their degree of specificity or generality, as will be seen in the examples that follow. IWAs can be found in structured job analysis questionnaires such as the Position Analysis Questionnaire (PAQ; McCormick, Jeanneret, & Mecham, 1972), Occupation Analysis Inventory (OAI; Cunningham, Boese, Neeb, and Pass, 1983), Job Element Inventory (JEI; Cornelius, Hakel, & Sackett, 1979),

General Work Inventory (GWI; Cunningham, Wimpee, & Ballentine, 1990), Common Metric Questionnaire (Harvey, 1991a), MOSAIC (U. S. Office of Personnel Management, 1991), National Job Analysis Study Work Activities Survey (NJAS; American College Testing, 1994), and O*NET project inventories. Examples of IWAs from these sources include: "[use of] Precision tools...Drawing and related devices...[stationary] Machines/equipment...Powered land vehicles" (from the PAQ); "Maintaining/Repairing/Setting Up Machines...Decorating/Styling...Automated Data Processing...Technical Drawing...Bookkeeping/Accounting...Stocking/Inventorying...Using Medical/Health Information...Using Economic Information...Caring for Plant Life...Waiting-On/Attending (to the needs/requests of others)...Supervising (the work of others)...Work-Related Socializing" (from the GWI); "Use blueprints, maps...Observe the operation of machines or equipment...Purchasing materials or supplies...Changing the types or levels of services offered to customers or clients...Establishing or changing work procedures or policies...[using] Desktop or personal computers...[using] Standard office equipment...[using] Mobile powered tools or equipment" (from the CMQ); "Establish policies or guidelines...Establish networks with key individuals or groups...Market work plans to higher management...Match subordinate interests and abilities with the job...Prepare staffing plans..." (from the MOSAIC Leadership Effectiveness Survey); "Listen to the concerns of clients/customers...Evaluate the work performance of other people...Inspect products, equipment, or materials...Design equipment, products, or services...Install systems (such as mechanical, electrical, communication)...Put parts together according to knowledge, instructions, or specifications" (from NJAS); "Drafting, Laying-out and Specifying Technical Devices, Parts and Equipment...Inspecting Equipment, Devices, etc....Controlling Machines and Processes...Operating Vehicles and Mechanized Devices/Equipment... Repairing, Maintaining or Adjusting Devices/Equipment (Electronic)...Communicating with Persons Outside the Organization...Selling/Influencing Others...Guiding/Directing/Motivating Subordinates...Training, Coaching and Developing Others" (from the O*NET project). In addition, IWAs might be developed from such sources as the O*NET prototype Knowledges and the USES Work Fields (U. S. Department of Labor, 1991). As with the AWAs, IWA-level descriptors might include statements of information or subject matter content, tools/machines/equipment used, and objects/materials acted upon. Some of the forenamed instruments do, in fact, contain such descriptors.

(3) Foundation Work Activity (FWA): The FWA applies to the broad spectrum of occupations and, unlike the AWA and IWA, is relatively free of job or technological content. FWAs correspond to the more basic and general (foundation) capabilities, ranging from the Sensory and Sensorimotor abilities to Cross-Functional Skills in the previously defined capabilities hierarchy. FWAs would be termed "worker-oriented" by E. J. McCormick (1959), whose Position Analysis Questionnaire was premised on that concept (McCormick, Jeanneret, & Mecham, 1972; McCormick & Jeanneret, 1988). FWAs can also be found in some of the other previously cited structured job analysis questionnaires. Examples of FWAs might include: "Verbal...Tactual ...Odor...Written materials...Pictorial materials [as sources of information]...Estimating quantity...Reasoning...Analyzing...Using mathematics ...Handling objects/materials...Balancing...Standing... Finger manipulation...Persuading...Writing" (from the

PAQ); "[S]eeing detail at about normal reading distance...[D]etecting/recognizing/judging sounds and differences or changes in sound quality...Reading...Ordinary Speaking... Studying/Evaluating...Creating Ideas...Detecting Problems...Using Basic Arithmetic ...Planning...Visualizing Objects...Working with hands...Communicating...Being Supervised ...Cooperating...Evaluating Others....Settling Conflicts...Bargaining...Leading Group Discussions/Meetings" (from the GWI); "Walking...Measuring/counting...Classifying/ categorizing... [using] Formal, grammatically correct English...Assisting...Socializing" (from the OAI); "Informally exchange information or ideas...Coordinate or schedule work activities...Supervise or evaluate projects or people...Diagnose or solve problems...Use spoken words in English...Use written words in a foreign language...Use pictures, drawings, patterns, graphs...Use sight to see differences in colors ...Make repeated exertions of physical force" (from the CMQ); "Summarize written information from a number of sources...Count people, products, materials, or money...Judge the importance, quality, and accuracy of information...Schedule work activities for oneself...Record verbal information in writing or in a computer file...Read charts or graphs to identify trends or patterns...Refer to alphabetical listings to locate and get information quickly...Collect money and make change...Set goals with other team members" (from NJAS); "Performing Physical Activities Requiring General Body Movements...Using Information Sources [from written documents, numbers, displays, graphics, etc.]...Identifying Objects, Actions, Events...Compliance [to a set of standards]...Analyzing Data and Other Information...Making Decisions and Solving Problems...Thinking Creatively...Organizing and Planning...Negotiating...Coordinating Others" (from the O*NET project). Some of the O*NET prototype definitions of Abilities, Basic Skills, and Cross-Functional Skills could also be transformed into manifested FWAs.

Position. "A...group of tasks performed by one person....There are always as many positions as there are workers in a plant or office" (Shartle, 1952, p. 25); "...a set of duties, tasks, activities and elements able to be performed by a single worker" (Levine, 1983, p. 3); "...a collection of tasks constituting the total work assignment of a single worker" (U. S. Department of Labor, 1991, p. 2-1). McCormick (1979a) adds that a "position exists, whether occupied or vacant" (p. 19), and the U. S. Department of Labor points out that under this definition, "There are as many positions as there are workers in the country" (p. 2-1). This definition, as well as those of "job" and "occupation" below, has persisted for over 40 years.

Job. "A group of similar positions in a single plant, business establishment, educational institution, or other organization...There may be one or many persons employed in the same job" (Shartle, 1952, pp. 25-36); "...a group of positions which are identical with respect to their major or significant tasks" (McCormick, 1979a, p. 19)...."and sufficiently alike to justify their being covered by a single analysis" (U. S. Department of Labor, 1991, p. 2-1); "...a set of positions which are similar enough in the activities performed by workers or in the goals they serve for an organization so that everybody in the organization agrees to call the positions by the same job title" (Levine, 1983, p. 3). Because positions subsumed under the same job title are assumed to have similar tasks and duties, they are similar in terms of generalized work activities as well. Jobs are the basic units analyzed by the USES in compiling Job Analysis Reports which, in turn, are merged into the occupational descriptions appearing in the DOT (U. S. Department of Labor, 1977).

Occupation. "...a group of similar jobs found in several establishments" (Shartle, 1952, p. 26); "...jobs of a general class, on an across-the-board basis, without regard to organizational lines" (McCormick, 1979, p. 19); "a job or job family found across a number of organizations" (Harvey, 1991b, p. 80); "...a group of jobs, found at more than one establishment, in which a common set of tasks are performed or are related in terms of similar objectives, methodologies, materials, products, worker actions, or worker characteristics" (U. S. Department of Labor, 1991, p. 2-1). Thus, jobs subsumed under a common occupational title are assumed to be similar in terms of tasks and duties, as well as the more general descriptors as previously defined. An occupation is an abstraction several steps removed from the concrete observable activities of individuals. It is both a hypothetical construct and the basic taxonomic unit within a more complex model of reality, the occupational classification system. The best known, most widely used examples of occupations are the 12,741 taxonomic units defined in the current DOT. Although a broader definition of "occupation" may prove more useful in the future, the preceding one is the established definition at this time.

Occupational Group or Cluster. A group of occupations with similar human requirements. Pearlman (1994) has defined "occupational/skill cluster" as "a grouping of occupations involving similar skill requirements based on similar job activities or functions" (p. ii). Similarly, McCage (1994) has defined an occupational cluster as "...a group of occupations and/or jobs skills that can be grouped together based on common characteristics such as functions, duties, tasks, and skills" (p. 10). Because we propose to describe occupational characteristics in terms of activity statements rather than human attribute definitions, we shall define an occupational cluster as a group of occupations with similar requirements as represented by the previously defined Generalized Work Activities (i.e., AWAs, IWAs, and/or FWAs).

The desired scope or inclusiveness of a cluster depends in part on its intended purpose and in part on the nature of the occupations in question. For example, clusters designed for validity generalization of aptitude tests (e.g., Hunter, 1983a) would be broader than those designed for occupational exploration and guidance which, in turn, would likely be broader than those intended for advanced occupational training. Holding purpose constant, optimal cluster breadth also might vary with differing characteristics of the constituent occupations. In the case of occupational transfer/retraining, for example, one might expect occupations requiring long preparation periods (in education, training, and/or experience) and more complex, technologically detailed KSs to merge into narrower clusters than those requiring short preparation periods and KSs of a less involved nature. As an extreme contrast, it might prove less useful to lump "Orthopedic Surgeon" into a broad Health Diagnosing and Treating cluster than to put "Carpenter Helper" into a broad Routine Construction-Work cluster. The cost of occupational transfer (in retraining and lost investment in previous training) increases with the preparation requirements of the occupations. Even when preparation time is constant, moreover, some KSs are transferable across broader technological content ranges than others. Thus high-level managerial and accounting KSs are more readily transferable across industries than the KSs associated with aeronautical or nuclear engineering. Examples of occupational clusters and cluster frameworks follow.

Approaches to Occupational Grouping

Humans seem to have an inherent need to classify things. As noted by Mezzich and Solomon (1980), "There is evidence of classificatory efforts since the dawn of mankind....Folk taxonomic systems have been found from very ancient times and are distributed widely throughout the world" (p. 3). Recorded efforts to define different kinds of occupations trace back at least as far as Socrates and Plato, and large-scale occupational encyclopedic efforts emerged as early as the Eighteenth Century (Primoff & Fine, 1988; Rouse, 1956). To date, virtually all occupational classification systems have been rationally derived. More recently, however, there has been increased interest in numerical grouping through application of computerized clustering algorithms to jobs' and occupations' profiles on descriptors such as those previously described. The latter efforts have been encouraged by the development of structured job analysis procedures and the increased capability and accessibility of computers and their software (Harvey, 1991b).

Rationally Developed Occupational Groupings

Among the best known rationally developed classification systems are: the Dictionary of Occupational Titles (DOT), Standard Occupational Classification (SOC) Manual, Occupational Employment Statistics (OES) Structure, U. S. Census Occupational Classification System, International Standard Classification of Occupations (ISCO), Guide for Occupational Exploration (GOE), Canadian National Occupational Classification (NOC), United Kingdom's Standard Occupational Classification (UKSOC), and most recently, the Prototype Skills-Based Job Family Matrix developed by the Bureau of Labor Statistics. Most of these systems are hierarchically structured, starting with very broad categories that subdivide into successively smaller (and narrower) occupational groupings (Lawrence, 1988; Michigan Occupational Analysis Field Center, 1992). Four systems--ISCO, NOC, UKSOC, and the BLS Job Family Matrix--classify according to skill level as well as content (skill type). The NOC and the Job Family Matrix, for example, cross these two sets of categories to form a level-by-content matrix whose cells contain hierarchical cluster arrangements (i.e., clusters are nested within cells). In addition to the GOE, systems for use in career development and guidance have been offered by Roe (1954, 1956), Super (1957), and Holland (1966, 1973; Gottfredson, Holland, & Ogawa, 1982), whose work-related personality theory has had a prominent, widespread heuristic and practical influence on the field. Roe's model, crossing occupational level with occupational content, might be considered a precursor to the NOC and Job Family matrices. The GOE contains the only classification scheme whose major categories were empirically induced (through factor analysis of interest item responses; Droege & Hawk, 1977), although the six dimensions in Holland's model accord with previous factor analytic interest research (e.g., Guilford, Christensen, Bond, & Sutton, 1954; Torr, 1953). For occupational education purposes, the U. S. Office of Education developed a comprehensive structure of 15 broad occupational clusters "...sub-divided into a number of sub-clusters, which [were] further `shredded out' into more discrete functions at increasing levels of specificity" (Russo, 1972, p. 4; Vestal & Baker, 1972; Hoyt, Evans, Mackin, & Mangum, 1972). More recently, the U. S. Department of Education has developed a classification system for occupationally related instructional programs (Classification of Instructional Programs, CIP; Morgan, Hunt, & Carpenter, 1990), which has been used by V-TECS to organize and cluster occupational education programs (McCage, 1994).

The process by which occupational groupings are rationally developed may be relatively explicit or implicit in terms of the underlying conceptual framework, and structured or unstructured in terms of procedures. An explicit approach would involve the derivation of occupational categories from an explicit theory such as Holland's, or from a set of predetermined classification dimensions such as those in Roe's model, the NOC, or the BLS Job Family matrix. A completely implicit approach would involve judgmentally grouping occupations on a global, inductive basis--relying on "the configural ability of the human mind" (Mezzich & Solomon, 1980, p. 20)--and then attaching labels to the resultant groups. In practice, all of the forenamed classification systems reflect combinations of both approaches in varying degrees, where broad defined frameworks were used to focus more implicit judgmental efforts, i.e., where the broad categories were explicit and the narrower groupings were implicitly derived. The approach used heretofore in developing occupational classification systems has been relatively unstructured, with individual participants determining their own strategies for defining categories and groups. Under structured procedures, on the other hand, participants would generate ideas and make judgments according to a defined set of rules and procedures. For example, focus groups might be used to generate occupational categories or clusters, and knowledge-acquisition techniques (Kidd, 1987) could help groups of SMEs (subject matter experts) identify the salient variables that either underlie the categories or could be used to generate categories. The Delphi technique (or some other structured procedure) might then be used to reach consensus on the assignment of occupations to the categories, perhaps coupled with established methods such as Q-sorting and analyses of inter-judge agreement. The salience of initially identified descriptor variables could be confirmed through policy-capturing regression analyses (e.g., discriminate analysis) using occupations' ratings on the variables as predictors of their group memberships.

SMEs could be asked to Q-sort occupations into tentatively established occupational categories, or they could be asked to sort occupations into groups as induced individually by each sorter. Under either method, the relative frequencies of the occupations' co-assignments to groups could be used to derive a matrix of pairwise association indices among all occupations in a sample, which then could be cluster analyzed to produce a summary set of occupational groups representing a condensation of the SME's judgments. Although there is a limit to the number of occupations that could be grouped this way, this method (or some variation of it) might prove useful in forming subgroups within confined occupational categories such as SOC minor groups or OES 3-digit groups. In research at N. C. State, we have found similarly derived clusters to be valid against external standards (e.g., 3rd ed. DOT Worker Trait Groups) and to provide a reasonable criterion for validating clusters derived from job descriptor profiles as described below (Ballentine, Cunningham, & Wimpee, 1992; Hamer & Cunningham, 1981). This technique brings us to the threshold of numerical grouping, the approach we will discuss next.

Classification systems based on the rational approach have the advantages of being relatively economical to develop, comprehensive in scope, and intuitively meaningful. They capitalize on the ability of the human mind to detect, consider, and synthesize various (often subtle) characteristics and differences that might not be captured by a computerized numerical procedure. Some potential disadvantages are that (a) the processes through which such systems are derived do not always explicitly identify salient underlying variables to tell us why an occupation belongs to a particular group; (b) different individuals will likely consider different variables (or weight the same variables differently) in forming groups or assigning occupations to them; (c) compared to the numerical alternative described below, the rational process may not take as many variables into account in forming the categories or groups; and (d) the salient variables that are identified may not be sufficiently numerous, defined, and measured to support subsequent electronic assignment of jobs/occupations within the completed system.

Numerically Derived Occupational Groupings

Under numerical classification, jobs or occupations are assigned numerical values on a set of descriptors, such as those previously described, and the resultant descriptor profiles are used as a basis for clustering. It should be noted that although the numerical classification process itself is empirically inductive, the descriptors on which it is based are derived through a rational process (i.e., theory and deduction). This approach originated in the field of biology, where several thousand scientists have been working on taxonomic problems for years (Haggard, 1963; Sneath & Sokal, 1973; Sokal, 1974). (In contrast, occupational taxonomy can claim very few long-term, full-time participants.) Fleishman and Quaintance (1984) offer an excellent treatment of taxonomic issues in human performance, in which they suggest that "...'numerical taxonomy' may have the most to offer for taxonomic efforts in the behavioral sciences in the long run because of its emphases on quantification, objectivity, and empirical verification" (p. 29). The kinds of descriptors used in numerical job and occupational clustering have included many of the previously defined worker and occupational characteristics. Perhaps the earliest published effort to group jobs numerically--and almost certainly the first to do so based on knowledges and skills--was reported by Coombs and Satter (1949). Cunningham (1971) and Pearlman (1980) have reviewed the studies in job and occupational clustering up to the times of their writings. As noted by Pearlman, the nature of the descriptors reflects the purposes for which the clusters are intended.

Although the field of numerical job/occupational taxonomy is relatively new, there is a cumulative body of evidence supporting its viability. The most frequently used clustering descriptors are those contained in structured job analysis questionnaires. Analysts in the U. S. Air Force, for example, have made extensive use of incumbents' job-task inventory ratings to cluster positions into jobs (Christal & Weissmuller, 1988), and other investigators have used more generic descriptors to group jobs within specified areas, such as clerical (Thomas, 1952), sales (Dunnette & Kirchner, 1959), agriculture and metal working (Sjogren, Schroeder, & Sahl, 1967), insurance (Taylor & Colbert, 1978), line supervision (Dowell & Wexley, 1978), and management (Tornow & Pinto, 1976). The relatively few studies encompassing wider ranges of jobs/occupations have used previously cited general nomothetic questionnaires (containing IWAs and FWAs), including the PAQ (Shaw, DeNisi, & McCormick, 1977), OAI (Pass & Cunningham, 1977), JEI (Cornelius, et al., 1979), and GWI (Ballentine, Cunningham, & Wimpee, 1992).

An extensive research effort at N. C. State involved a series of studies culminating in the derivation of numerical job clusters from OAI ratings of 1,414 jobs sampled proportionate to percentages of the U. S. work force employed in major occupational categories (as reported by the U. S. Bureau of the Census). This research produced a hierarchical cluster structure that was replicable, judgmentally meaningful relative to two existing classification schemes (3rd ed. DOT worker trait areas and the occupational divisions and major groups), and empirically valid compared to (a) the GOE interest areas and work groups, (b) clusters derived from SMEs' pairwise similarity ratings of 50 jobs drawn from six 3rd ed. DOT worker trait groups, and (c) the 50 jobs' OAI cluster membership agreement with the six worker trait groups (Hammer & Cunningham, 1981; Scott, 1989; Scott, Cunningham, & Pass, 1989). Another major effort at N. C. State involved cluster analyses of a stratified sample of 173 Air Force enlisted jobs based on GWI position ratings by 1,767 incumbents. This research produced a meaningful and replicable job grouping structure that proved empirically valid in comparison to existing career field classifications and to groups derived from SMEs' pairwise similarity ratings of 40 enlisted jobs (Ballentine, Cunningham, & Wimpee, 1992). Appendices A and B summarize clusters derived with the OAI and GWI respectively. Appendix A presents the titles only for 21 broad ("macro") clusters, omitting their subsumed "micro" clusters; Appendix B presents the titles of clusters at the hierarchical level judged to be most meaningful. These clusters are the results of exploratory research and are not presented as final products. Because they were derived with IWAs and FWAs (excluding AWAs), there was some limit to the level of specificity that could be meaningfully resolved in their hierarchical solutions. However, we believe they do demonstrate the feasibility of the numerical approach to classification.

The numerical approach offers the advantages of (a) explanation through explicit identification of the salient variables on which clusters are based; (b) the capability to involve large sets of accountable variables in the clustering decision and control their relative weighting; (c) electronic assignment capability; and (d) as a side benefit from descriptors such as IWAs and FWAs, the capability to estimate jobs' human attribute requirements through the job-component approach to be described later. Compared to rationally developed groupings, numerical clusters also are probably less likely to be contaminated by preconceived notions (although this is not necessarily so for their underlying descriptors), and thus may be more valid or isomorophic with the "real" world. Among the disadvantages of numerical classification are: (a) the time and expense required to define and develop descriptors, rate large samples of jobs/occupations on them, and carry out cluster analyses; (b) the necessity to develop descriptors and carry out analyses at more than one level of specificity (e.g., IWAs and AWAs) in order to develop a comprehensive yet sufficiently detailed classification system; and (c) the possibility that numerical clusters may be less intuitively meaningful than rationally developed ones. Finally, it should be noted that the quality of a numerical cluster structure rests on the adequacy of the descriptors, job/occupational sample, and analytical method on which it is based. In that regard, several methodological issues must be addressed in developing a numerical classification system, including for example: (a) the descriptors to be used at different levels of classification, (b) whether the selected descriptors should be differentially weighted, (c) the appropriate profile association measure for clustering purposes, (d) the appropriate clustering algorithm, and (e) the criterion for determining the appropriate number of clusters. Decisions on these issues can affect the nature and quality of the resultant cluster structure, and the computerized clustering procedure cannot adjust for bad decisions or measurement error in the descriptors. It will do what it is programmed to do; if "Orthopedic Surgeon" should end up in the same cluster as "Hog Ribber," it will not care. In comparison, the rational approach is somewhat more forgiving in that the informed human mind can often deal with these matters intuitively. The numerical approach, on the other hand, has an offsetting advantage in its capacity to deal simultaneously in a formulated way with large numbers of variables and cases.

V. A STRATEGY FOR REVISING THE SOC

Considering the present stage of development in occupational classification/taxonomy and the comparative advantages and disadvantages of the rational and numerical alternatives, we propose combining the two approaches. As mentioned, the numerical method excels in large-scale data processing, whereas the human mind can account for factors and subtleties that may slip through the numerical net. Accordingly, we think that the numerical method would prove useful in providing input to a rational evaluation and revision process. Above all, the classification system must be intuitively meaningful to its users.

Another basic premise for our proposal is that the revised SOC should be hierarchically structured (as is the present SOC), with small groups nested under large groups; e.g., broad divisions subdivided into major groups, subsuming minor groups that, in turn, subsume unit groups. As noted, most established classification systems are hierarchically arranged, and for good reason we think (Lawrence, 1988; Michigan OAFC, 1992). In addition to their relative simplicity and parsimony, the hierarchical classification structures allow different users to work at different levels of generality or specificity depending on their needs. Although other kinds of classification arrangements have been suggested, most of these alternatives would be strained to provide multiple levels of generality and some, such as "fuzzy" or overlapping clusters, would be confusingly complex.

Finally, we propose that skill-level categories be introduced into the revised classification system. A number of recently developed systems incorporate skill level, including the ISCO, Canadian NOC, UKSOC, and BLS Job Family Matrix. Consistent with the NOC and Job Family Matrix, we envision a broad level-by-content grid as an overarching classification framework. A similar framework has been proposed recently by Sheets (1994).

A General Framework

Units of Analysis

Previously, we cited as examples of "occupations" the 12,741 defined titles (9-digit codes) representing the finest level of differentiation in the DOT. Although the finest differentiations in the SOC and OES hierarchies are coarser than those in the DOT, the 9-digit DOT codes and titles have been classified under the narrowest categories in both systems (663 SOC unit groups and 756 OES 5-digit groups). The proposed approach to SOC revision involves collecting generalized work activity (GWA) rating data for occupations, which would require selection of a basic unit or object of analysis. Possible choices include jobs, DOT 9-digit occupations, SOC unit groups, and OES 5-digit groups. To begin this effort at the job level, working upward, seems prohibitively time consuming and expensive. On the other hand, we think that the SOC and OES groups are probably too broad to serve as units of analysis, leaving the DOT occupations as the surviving candidates. We think it would be impractical, however, to rate all 12,741 DOT occupations on a large set of GWAs, which leaves us the option of rating a representative sample of those occupations drawn from various categories (such as the OES 5-digit groups). But this latter approach would dilute one of the main advantages of using GWAs as descriptors: the numerical-electronic assignment of occupations to categories (i.e., how do we assign all the unrated occupations?).

A possible alternative would involve merging the 12,741 DOT occupations into narrow clusters, below the level of SOC unit and OES 5-digit groups, collapsing them to a more manageable number of "occupational units" (OUs). One of the present authors is currently participating in a promising exploratory effort to cluster DOT titles within OES 5-digit groups. Within each of a selected sample of OES groups, 9-digit DOT occupations are numerically clustered based on DOT descriptor profiles, and the occupations' cluster memberships are then subjected to rational evaluation/revision based on SMEs' estimates of retraining time required to transfer to representative (seed) occupations within and across clusters. Examples of clusters (OUs) derived within two OES 5-digit groups are shown in Appendix C. It is estimated that this effort, if carried to completion for all OES 5-digit groups, would produce 1200-1500 OUs. The number of OUs would be within manageable limits for GWA rating purposes and would still provide a bridge to the more numerous and specific 9-digit occupations. Although OUs seem preferable to representative DOT occupations as objects of analysis under the proposed strategy, the question of which will prove most practical cannot be resolved here. Hereafter, we will simply refer to the units of analysis as "occupations."

Content Divisions: Matrix Columns

The columns in the proposed matrix would be marked by content divisions analogous to those in the NOC, Job Family Matrix, and Sheets (1994) model. The first step in column derivation would involve development of a general occupational analysis questionnaire (OAQ) containing several hundred intermediate work activity (IWA) and fundamental work activity (FWA) statements drawn or adapted from the previously cited sources. Analysts/SMEs would then rate the selected occupations on the OAQ activity statements. Mean values over multiple raters would ensure stable occupational profiles on the descriptors. It might prove useful to condense the descriptors to more basic dimensions through factor analysis.

The next step would involve clustering the occupations based on their numerical descriptor profiles. A decision would be required (possibly based on initial exploratory analyses) as to whether to use individual IWAs and FWAs as profile variables or to use factors. Another issue would be whether to include only IWAs (or IWA factors) as profile variables, excluding FWAs because of a possible skill-leveling influence that might preempt the skill-level categories to be described subsequently. (Regardless of that decision, FWAs should be included in the initial occupational ratings because of their other potential uses.) Decisions also would be required regarding the clustering methodology issues identified earlier. We anticipate that this approach would yield 25-30 broad occupational clusters. Exploratory research with the Occupation Analysis Inventory (OAI) produced 21 "macro clusters" (Pass & Cunningham, 1977). The OAI contains both IWAs and FWAs and, as can be seen in Appendix A, there were some skill-level differences among the resultant clusters.

The numerically derived clusters would then be subjected to structured rational evaluation and revision. The rational procedure could be carried out in a number of ways, including those identified earlier. As an example, the numerical clusters could be systematically compared with division categories from previously cited classification systems. (Another set of categories that might be included in the comparison are factors/clusters derived from the occupations' USES Work Field and MPSMS designations. The results of a very exploratory factor analysis carried out by two of the authors in collaboration with R. R. Boese are shown in Appendix D.) SMEs could perform category Q-sorts, and the categories from all the systems could then be grouped through cluster analysis of pairwise co-occurrence indices (based on relative frequencies of joint Q-sort assignment). Assuming that occupations could be assigned to all the included categories, pairwise category similarity measures might also be generated by intercorrelating the mean descriptor profiles of the categories' constituent occupations; another possible pairwise association measure would be based on membership overlap between categories. In addition to cluster analysis, convergent-discriminant analyses could be performed on indices of pairwise category similarity to establish cross-system construct agreement. At the end, this procedure will have condensed the divisional categories from several systems into one set of clusters. The results of this effort would then be subjected to further rational examination (perhaps through the Delphi technique) to identify a final set of content divisions to form the column categories in the proposed matrix. Regardless of what the final set of divisions might be, they would characterized by the mean descriptor profiles of their constituent occupations, which would provide a basis for subsequent numerical-electronic occupational assignment. The advantage of the numerical descriptors (IWAs and FWAs) is fourfold: (a) they can be used to form an initial set of categories; (b) they can be used to assign occupations to established categories; (c) they explain why an occupation belongs in a particular category; and (d) as will be described later, they can be used to estimate human capability requirements.

The methodological details in the foregoing description are, of course, only examples of how the general strategy we propose might be implemented. There are a number of methodological variations that could be applied.

Skill-Level Categories: Matrix Rows

There are also several possible conceptual and methodological approaches to defining "skill level." The most direct approach would use existing scales such as the current DOT General Educational Development (GED) and Specific Vocational Preparation (SVP) scales or the education and work experience scales developed on the DOT Prototype Project. One advantage of the current DOT scales is that rating data are available for all 9-digit occupations. Scores on those scales would first be combined into a single composite, and then cutoff values would be determined to divide the composite scale into skill-level categories. There has been criticism of this general approach, however, on the basis that it omits some salient aspects of skill level.

Another approach would be based on the construct of cognitive complexity, which has been proposed as a major factor underlying job performance (Cain & Treiman, 1981; Hunter, 1983, 1986). In a study conducted at N. C. State, factor and cluster analyses were performed on 34 worker-oriented DOT variables based on the ratings of 12,375 occupations (Cunningham & Scott, 1988; Scott, 1989). The results--which were similar to those from an earlier analysis by Cain & Treiman (1981) including 44 DOT variables and a sample of 1,172 occupations--contained six interpretable and very stable factors (and corresponding clusters), one of which appears to be a good representation of cognitive complexity. The resulting clusters, which were better differentiated than the factors, are shown in Table 1 of Appendix E. Table 2 in Appendix E presents clusters from an analysis of a combined set of DOT and OAI worker-oriented variables, based on the ratings of 1,034 occupations. The clusters in Table 2 are presented to enhance the interpretation of those in Table 1. Several of those clusters might be linked to Reich's (1992) three broad categories of work. Occupations scoring high on the Cognitive and Managerial Activity clusters would probably belong in Reich's Symbolic-Analytic Services category; those characterized by the variables in the Skilled Social Activities cluster might fit into his In-Person Services category; and those with a heavy involvement of the variables marking the Skilled Motor, Demanding Physical, and/or Clerical Activities clusters would likely belong in the Routine Production Services category (see Table 2, Appendix E). Because the DOT occupations are already rated on the constituent variables in the Cognitive cluster, cluster scores could easily be computed for them, and category boundaries could be established along the cluster score distribution. However, the use of a cognitive complexity scale alone to determine skill-level categories would be subject to same criticism as the GED/SVP scale, that it is too univocal or restricted. Although that problem might be addressed by subjectively weighting additional clusters in Appendix E and combining them into a composite scale, there are probably better ways to combine multiple factors (as will be noted subsequently).

A third approach that might be considered would use basic occupational dimensions to capture market policy in setting wage and salary levels, under the assumption that an occupation's average compensation rate reflects its skill-level requirement. The methodological approach, pioneered by E. J. McCormick and his associates in the field of job evaluation, involves regressing the mean compensation rates for a representative sample of jobs or occupations on selected job descriptors (Jeanneret, 1980; McCormick et al., 1972; McCormick, DeNisi, & Marquardt, 1974). Once the regression equation is established, compensation rates can be estimated for any job/occupation that is scored on the descriptors. For present purposes, the descriptor variables (compensation predictors) might be selected from the previously described DOT worker-oriented factors/clusters, GWAs from the DOT Prototype Project, and/or factors derived from occupations' FWA ratings. The distribution of estimated compensation rates (composites of regression-weighted descriptor scores) would provide the basis for establishing skill-level categories. A practical problem with this approach would be the difficulty in finding sufficient compensation data at the occupation or unit level. A more serious problem, however, is the likely objection that occupational compensation rate is not a pure manifestation of skill-level requirement, because systematic variables in addition to skill enter into its determination.

A final option to be considered would involve policy capturing "expert" judgment as to the appropriate assignment of occupations to skill levels. Under this approach, qualified judges would sort a representative sample of occupations into predetermined skill-level categories or, alternatively, simply assign category ratings to the occupations. (An optional feature would involve marking the end and middle categories with "anchor" or example occupations selected through initial scaling research.) Differences between judges could be resolved through a structured group procedure such as the Delphi technique, or occupations with inconsistent sorts could simply be removed from the data set. Following the assignment procedure, a discriminant analysis would be applied to the skill-level categories and their constituent occupations, using perhaps 5 or 6 of the previously suggested occupational descriptors as the discriminating variables. The resultant discriminant functions would then be used to assign all remaining occupations to skill-level categories. We would anticipate the involvement of at 10-20 judges, sorting a sample of 300-400 occupations into 5-7 skill-level categories. This approach offers the advantages of (a) multiple determiners of skill level (the discriminating variables), (b) pre-established skill-level categories, which eliminate the necessity of determining category boundaries on a score continuum, and (c) skill-level comparability across content categories. The most likely target of criticism would be the validity of the SMEs' sorting judgments. Some difficulty also might arise in regard to sample size, or number of cases (occupations) relative to the numbers of discriminating variables and categories (cf. Nunnally, 1978). Nevertheless, we recommend this option for consideration because it avoids some of the problems associated with the preceding alternatives.

Regardless of the method used to establish skill-level categories and assign occupations to them, their cross-classification with the content categories will produce a matrix or grid containing occupations within its cells. (As in the BLS Prototype Job Family Matrix, it is possible that some cells will be vacant). In subsequent discussion, we shall refer to the matrix columns as "divisions" and the matrix cells as "major groups."

Clustering Within the Matrix Framework

This phase of the proposed effort would focus on subdividing the major occupational groups (matrix cells) into smaller minor groups and occupational unit groups. For that purpose, we recommend the development of an Area Work Activity (AWA, as previously defined) rating questionnaire for each of the 25-30 matrix divisions (columns). The division AWAs in these questionnaires might be supplemented with relevant IWAs and FWAs and perhaps, when judged necessary, AWAs specific to major groups. We might expect the typical AWA questionnaire (AWAQ) to contain in the neighborhood of 300 descriptors, which could later be condensed through factor analysis. Analysts/SMEs would rate occupations on appropriate AWAQs. Although the proposed questionnaire development task may seem formidable, it can be noted that the military services have been able to produce hundreds of job-task inventory questionnaires containing several hundred items each (Christal & Weissmuller, 1988; Mitchell, 1988; Mitchell, Ruck, & Driskill, 1988).

Occupations would be numerically clustered within each major group, based on their AWAQ descriptor or factor profiles, and minor-group clusters would be identified. The numerically derived minor-group clusters would then be subjected to a rational evaluation/revision procedure, as follows: (a) interpret each cluster based on its constituent occupations and mean descriptor profile, and assign it a name or title; (b) identify 2-3 "seed" occupations that are close to the cluster centroid (i.e., whose individual profiles closely match the mean cluster profile); (c) present SMEs with the minor-group cluster titles and titles of their seed occupations (and perhaps a brief written description), and ask them to sort all remaining occupations into the titled clusters; (d) identify occupations that a substantial number of SMEs assign to clusters other than their original numerical cluster; (e) submit the "misassigned" occupations to assessment through a structured group procedure such as the Delphi technique to determine whether they should be reassigned or left in their original numerical clusters. The Delphi method also could be used to determine whether any of the minor-group clusters should be merged or split, perhaps using as input options selected from the numerically derived hierarchical cluster structure.

Occupational groupings at the lowest or most specific level in the proposed system would be subsumed under the preceding minor groups. We shall call these "unit groups," consistent with SOC terminology. If the previously described "occupational units" were used as the basic objects of analysis, then these would also serve as unit groups in the classification system (see Appendix E for examples). If, on the other hand, a representative sample of 9-digit DOT occupations were used as objects of analysis, then more specific clusters, below the minor-group level, would be selected from the previously described hierarchical structure (i.e., the AWAQ-based numerical cluster structure) to serve as the unit groups. Under this latter approach, the unit-group numerical clusters would be subjected to the same rational evaluation/revision procedure as described for the minor-group clusters. At this time, however, we consider the "occupational units" as likely the best choice for both objects of analysis and unit groups. Current classification groups might provide a basis for comparison and evaluation of the proposed major-, minor-, and unit-group clusters, perhaps by procedures similar to those described for the division clusters. But it is unlikely that the current groups would adequately substitute for the derived clusters, because they were not (a) developed within fixed skill levels nor (b) formed on the basis of explicitly defined skill-oriented activities.

In summary, the proposed system would be structured within a matrix formed by skill-level rows crossing content-category columns, as shown in Figure 1. Occupations would be assigned to the matrix cells and hierarchically clustered within those cells. The content categories would be called "divisions"; the matrix cells, "major groups"; and the hierarchically arranged clusters within cells, "minor groups" and "unit groups" successively. The unit groups, in turn, would contain 9-digit DOT occupations. Groupings would be described at every level by their mean descriptor profiles. The descriptors would provide a basis for (a) electronic assignment of new occupations, (b) occupational grouping for special purposes, (c) later revision of the classification system as needed, and (d) estimation of occupational requirements for human capabilities and other attributes (as described in the next chapter).

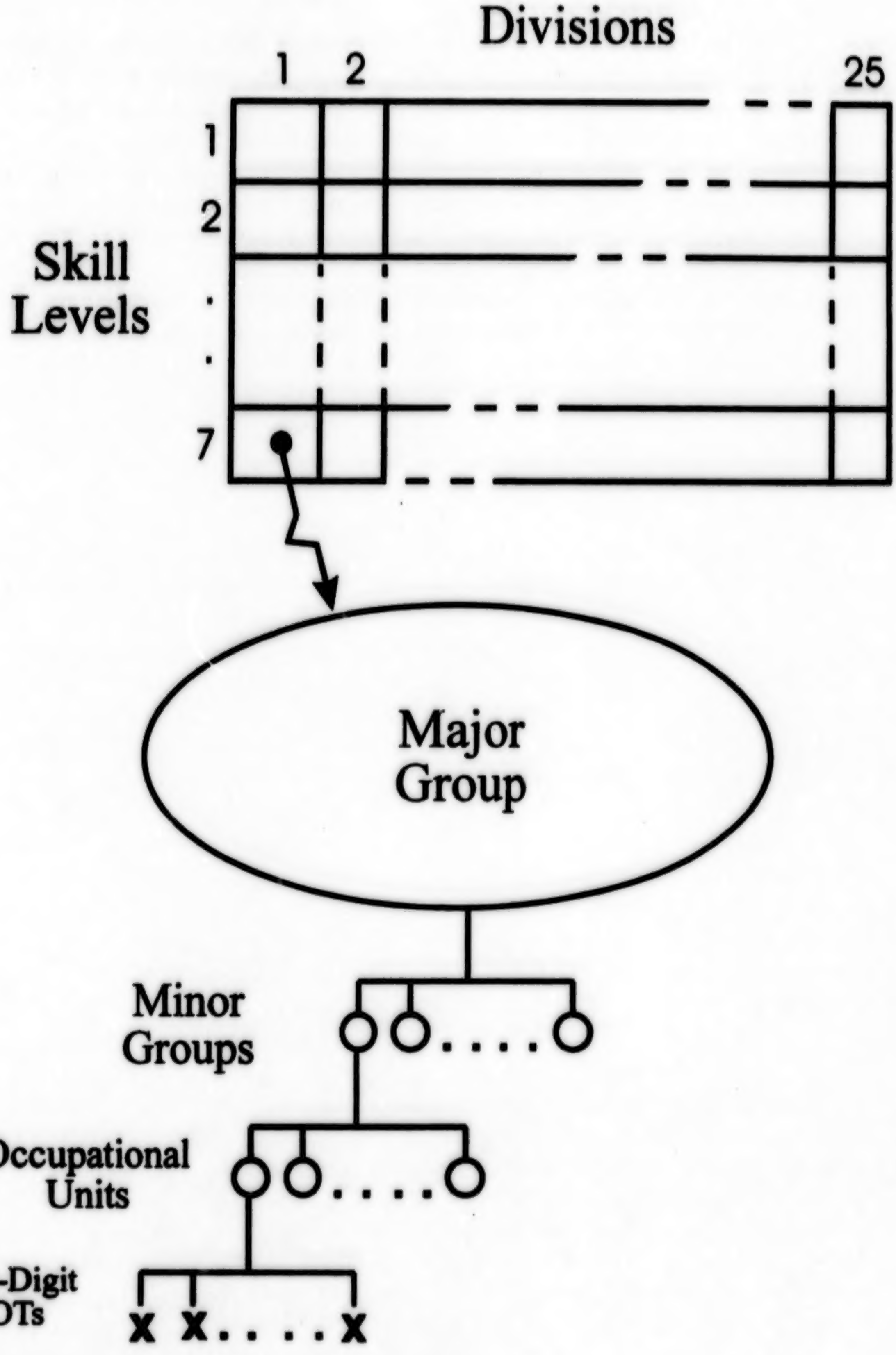

Figure 1. A proposed occupational classification framework.

The resultant skill by content level classification should be evaluated to determine the extent to which it would support the classification and coding functions as performed by the major agency producers of occupational information. Unit and minor groupings should be assessed to ascertain possible coding problems. Agency classification preferences should be identified, differences adjudicated, and acceptable compromises negotiated. Where groupings were judged to result in too small employment sizes to support statistical accuracy, adjustments should be proposed and corrective action taken. These corrective actions should be taken during an initial development stage devoted to remediation. After a fixed time period, the classification system should be implemented as an operational standard. Subsequent modifications and deviations should take place only in accordance with formalized revision procedures.

VI. INTEGRATION OF THE DOT WITH THE REVISED SOC

This chapter extends the framework for a revised SOC to include integration of a reengineered DOT. SOC-DOT integration involves two major components: linkage of the SOC descriptors and current DOT to the worker characteristics scales being developed by the O*NET project and organizing both existing and newly collected occupational data according to an acceptable occupational classification structure. These two components form the rationale for the organization of this chapter. The first section describes a procedure whereby additional occupational descriptive detail can be synthesized, thereby circumventing the necessity for incumbent surveys. The second section sketches the broad outline of a vision as to a means for structuring occupational data so as to realize the untapped potential of an electronic occupational database with user search, retrieval and update capabilities.

Linking Occupational and Worker Characteristics

Dunnette (1976) identified two separate domains of human behavioral taxonomy, one based on test behavior and the other on work behavior, and proposed a need for further efforts toward linking them. In that regard, he cited McCormick and his associates' research in structured job analysis (with the PAQ; McCormick, Jeanneret, & Mecham, 1972) as "an excellent first approximation for developing the common taxonomy that is needed" (p. 516). In a similar vein, Cunningham (1971) coined the term "ergometrics," a "...field of investigation [that] would draw from theories and principles of human behavior, as well as from established procedures in psychological measurement and job analysis." Among the several problems ergometrics would address was "...the establishment of relationships between work variables and existing measures of human attributes (i.e., tests in the cognitive, psychomotor, and affective domains)." Ergometrics was characterized as "...a `nomothetic' rather than an `ideographic' approach to the study of work (Allport, 1937; Tyler, 1965)--i.e., an approach emphasizing the common dimensions rather than the unique characteristics of tasks, jobs, and occupations" (pp. 7-8; also in McCormick, 1979a,b).

A strong suit of nomothetic job descriptors (NJDs), such as the previously defined IWAs and FWAs, is their potential linkage to many of the previously defined human attributes, particularly the more basic and fundamental capabilities. As mentioned, just as jobs can be characterized by work activities performed, human capabilities can be defined in terms of people's performance levels on specified classes of tasks (activities) as represented by items comprising tests. Similarly, work-related interests can be defined as preferences for specified classes of tasks as represented by the items comprising interest questionnaire scales, and work-related needs as preferences for broader classes of job rewards, opportunities, and conditions as represented by need scales. Thus, in attempting to establish a job or occupation's requirements for these attributes, one could ask to what extent the tasks represented in the tests are part of (or embedded in) the tasks performed in the job. Because IWAs and FWAs (hereafter referred to collectively as NJDs) represent concrete classes of work activities, we propose that they could serve as mediators in establishing job-test linkages--linkages between occupational and worker characteristics.

The proposed means of linking NJDs to human attributes has been termed the "job component" approach (McCormick, 1979a), under which (a) a universal set of job components (NJDs or NJD factors) is developed and (b) requirement weights are derived for the components on various human attributes. Subsequently, attribute-requirement estimates can be derived for any job that has been rated or scored on the weighted components. This approach is depicted in Figure 2, which shows a matrix of requirement weights of *q* job components for *k* defined human attributes.

$$\begin{array}{llccccccc}
 & & & & \multicolumn{3}{c}{\underline{\text{Human Attributes}}} & & \\
 & & \underline{1} & \underline{2} & \underline{3} & . & . & \underline{k} \\
 & \underline{1} & W_{11} & W_{12} & W_{13} & . & . & W_{1k} \\
 & \underline{2} & W_{21} & W_{22} & W_{23} & . & . & W_{2k} \\
\underline{\text{Job}} & \underline{3} & W_{31} & W_{32} & W_{33} & . & . & W_{3k} \\
\underline{\text{Components}} & . & . & . & . & . & . & . \\
 & . & . & . & . & . & . & . \\
 & . & . & . & . & . & . & . \\
 & \underline{q} & W_{q1} & W_{q2} & W_{q3} & . & . & W_{qk}
\end{array}$$

Figure 2. Requirement weights of *q* job components on *k* human attributes.

Based on the matrix in Figure 2, a job's estimated requirement for attribute 1, for example, could be derived by taking the sum of cross-products of the job's scores on the *q* components times the components' corresponding weights for attribute 1 (or by some alternative algorithm for combining job scores and requirement weights; cf. Sparrow, 1989). This procedure is depicted in Figure 3.

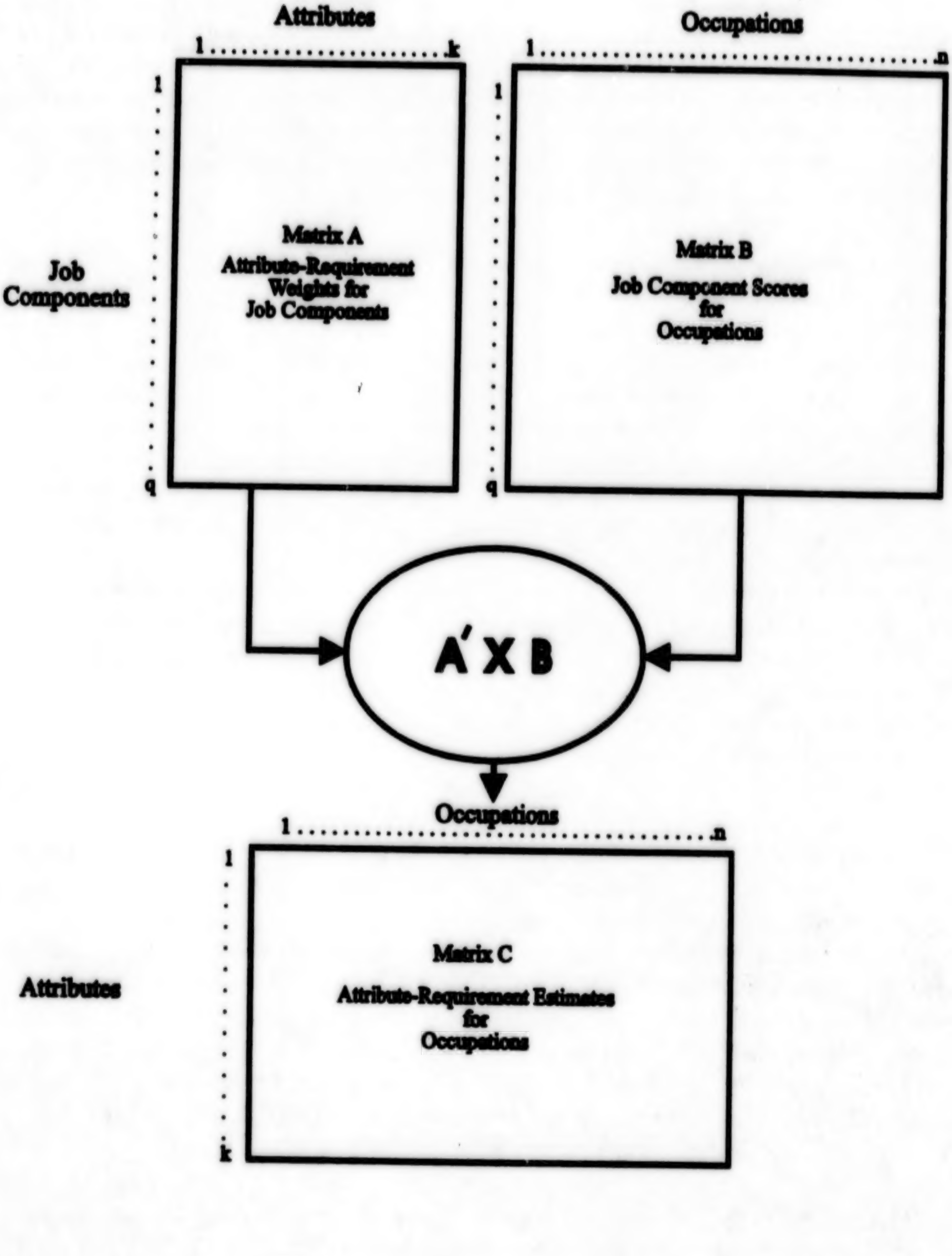
Attributes
1 . . . k
Occupations
1 . . . n
1
q
Job Components
Matrix A
Attribute-Requirement Weights for Job Components
Matrix B
Job Component Scores for Occupations
A' X B
Occupations
1 . . . n
1
k
Attributes
Matrix C
Attribute-Requirement Estimates for Occupations

Figure 3. Job Component Procedure for Estimating Attribute-Requirements of Occupations.

The job component approach has been tested with at least four general nomothetic job analysis questionnaires: the Worker Activity Profile (McCormick, Cunningham, & Thornton, 1967); the PAQ (McCormick, Jeanneret, & Mecham, 1972; McCormick, DeNisi, & Shaw, 1979); the OAI (Cunningham, 1988; Cunningham et al., 1983; Cunningham and Scott, 1988); and the GWI (Cunningham et al., in press; Powell et al., 1994; Wimpee & Cunningham, 1989). Some of the issues in job component methodology (e.g., alternative methods for deriving attribute weights and combining them with job ratings) were discussed in a previous paper (Cunningham, 1994; also Cunningham et al., in press). An ongoing research effort at N. C. State is addressing some of these questions.

We believe the job component approach offers a viable means of linking occupational and worker characteristics and estimating occupations' human attribute requirements. Further, we think this approach offers advantages over direct global ratings of a job or occupation's attribute requirements. Once a weight matrix as depicted in the preceding figure is established, an occupation's attribute requirements can be estimated from ratings by knowledgeable respondents on relatively concrete NJDs representing observable work activities and conditions, as compared to direct occupation ratings on the more abstract attribute definitions. Under the job component approach, the respondent is assigned the more straightforward task of indicating what the worker is required to do rather than inferring what attributes the worker must possess. Moreover, the job component approach provides a basis for explaining why a job or occupation requires a particular attribute (i.e., because it involves specified activities with those requirements), as opposed to relying entirely on the expert-judgment argument inherent in an occupation's direct attribute-requirement ratings. Based on the Spearman-Brown prophecy principle (Guilford, 1954), job component estimates of attribute requirements should also show higher reliabilities per analyst/respondent, because they are derived from the respondent's ratings on a number of weighted NJDs, rather than from single global job or occupation ratings on each attribute requirement.

A job component approach applying the proposed IWAs and FWAs at the occupation or unit level could account for human-capability requirements ranging from basic motor and cognitive abilities to general occupational KSs (GOKSs; and perhaps some general cluster KSs), as previously defined, as well as work-related interests and needs. Adding to the substantial PAQ findings supporting the validity of "synthetically" derived aptitude-requirement estimates for jobs and occupations, research with the OAI has also provided some support for the validity of synthetically derived GOKS, interest, and need estimates (Heath, Cunningham, & Augustin, 1975; Augustin, Cunningham, & Heath, 1975). Cluster KSs, most of which are too specific to be captured by IWAs, would instead be reflected directly in AWAs (Area Work Activities) or AWA factors.

Thus, through methodology just described, the same descriptors used to develop a new SOC could be used to capture the attribute-requirement variables in the current DOT and those developed recently on the DOT Prototype Project under the APDOT model. Based on substantial research evidence, we would anticipate that those variables, whether represented by direct ratings or captured synthetically, would condense into a more parsimonious and manageable set of meaningful factors (Cain & Treiman, 1981; Cunningham et al., in press; Cunningham et al., 1990; Cunningham & Scott, 1988; Powell et al., 1994, 1995).

Occupational Classification and Description in a SOC-Structured DOT

Under the proposed approach, the DOT would be organized according to the revised SOC structure. Although the new DOT would still be hierarchically arranged, its current categories, divisions, and groups would be replaced with the new SOC divisions, major groups, minor groups, and occupational units. The 9-digit DOT occupations would be retained and subsumed under occupational units. Because the new classification system would be skills oriented, it should promote the purposes of the DOT as outlined in the APDOT (1993) report. New occupations could be electronically assigned to the classification system based on their numerical profiles on the descriptors used to develop the system. The same descriptors (GWAs), if made available to the field in the form of structured job analysis questionnaires (on computer or hard copy), could be used to rate jobs and classify them within the taxonomy. The system would also facilitate the classification of job tasks and duties, which could be sorted (by the employer or other user) into the salient AWAs of their respective occupational units, thereby incorporating them into the system. Input from other sources, such as the large task/duty inventory compiled by V-TECS and task lists developed by the State of Michigan (McCage, 1994), could also be brought into the system. Over a period of time, extensive task/duty banks would be compiled for the AWAs and their superordinate IWAs. The job and task information from the field would provide useful feedback for system elaboration and revision. One might envision a comprehensive, vertically integrated occupational information/classification system with a wide range of uses. The system descriptors could, of course, also be used to profile, compare, and group jobs/occupations in a variety of other ways according to specific user needs (i.e, to develop custom-made classification structures).

The taxonomic variables (GWAs) used in developing the classification system would also provide a basis for describing groups at different levels in the hierarchy, based on their descriptor profiles, with the descriptions becoming more general as the classification categories broadened. Through either job component methodology or direct representation, moreover, the classification variables would capture the human attribute variables in the APDOT model, making those available for occupational description as well. The descriptions could be presented in two different forms: (a) the numerical profiles for occupational units and groups and (b) textual descriptions using salient descriptors as building blocks or modules, perhaps supplemented with task/duty examples (from banks compiled under AWAs) and classes of equipment and materials used. As the hierarchy condensed upward, proceeding from occupational units to divisions, some of the more specific variables (e.g., AWAs and perhaps certain DOT Prototype knowledges) would either drop out of the group descriptions or diminish in function to serving as examples rather than common denominators. Information about specific occupations or groups could be delivered to users electronically. Job ratings on the aforementioned descriptors could be entered by the user into an electronic information system which, in addition to classifying the job, would "synthesize" a tailored job description from the system building blocks. The job ratings, in turn, when compiled over a period of time, could prove helpful in DOT system maintenance and revision.

Because the GWAs would either directly represent or capture various knowledges, skills, and abilities (KSAs), they could provide a basis for inventorying human resource pools. Large employers, for example, could compile human resource capability inventories based on numbers of employees trained and/or experienced in various jobs and job groups requiring specified KSAs. Such information would be useful in organizational planning and development. This approach might even be extended to local, regional, and state populations, based on OES and Census data showing numbers of people employed, trained, and/or experienced in different occupational groups, which in turn would be profiled on KSA-related variables. Potential users of population KSA data might include employers, industrial recruiters, Chambers of Commerce, educational institutions, and government agencies. The KSA-related descriptors (or their factors) might also be treated as transfer dimensions with applications to such problems as job consolidation, multi-functional/cross-job training, and the determination of job transfer and advancement paths (e.g., for mid-career change, intraorganizational job transfer and career advancement, and retraining/relocation of displaced workers). Conceivably, KS training modules could be developed based on occupational and/or GWA clusters, to be drawn upon in the design of organizational and institutional education/training programs. Competency tests could be developed on a similar basis. Other applications might be found in areas of job analysis and design, such as: the development of enriched, "high performance" jobs; identification of performance assessment dimensions; teamwork analysis and team building; and identification of essential and nonessential components in jobs for ADA compliance.

In addition to providing for the classification and description of jobs/occupations and their requirements, the proposed system would (as already suggested) provide a framework for describing the associated characteristics, training, and work experiences of people in terms of the GWA-captured APDOT attributes as well as KSs represented directly by GWAs or GWA factors. Some of these variables would be assessed by psychological measurement devices, while others would be represented by educational, training, and work records. Such descriptors, when applied to individuals, would provide information about the person that could be linked electronically to job/occupational information within and across organizations, thus facilitating the person-job matching process. Large employers could develop electronic job and personnel information systems with applications in human resource planning, development, and utilization. Other applications could be found in such areas as career exploration, guidance, and choice; employment counseling and placement (e.g., one-stop placement services); skills competency testing/certification; educational/training program development; disability determination; and vocational rehabilitation.

The potential advantages of the proposed approach seem apparent when one considers the vast amount of occupational information to be dealt with, the rapid changes occurring in the world of work, and the capabilities of current electronic systems to store, process, and update large data sets. A numerical-electronic system would be in the true spirit of APDOT's proposed occupational database for the 21st Century. A continuation of the traditional approach to occupational classification and description, on the other hand, would fail to exploit state-of-the-art developments in job analysis, numerical taxonomy, and electronic information processing; it would not, in fact, deviate significantly from Diderot's initial occupational encyclopedic efforts in the 18th Century (Primoff & Fine, 1988).

Without a better understanding of the nature and structure of the world of work, we will be seriously handicapped in efforts toward work force development and utilization in the 21st Century. Unfortunately, there are no acceptable shortcuts. The necessary constructs, framework, and measures will not eventuate absent the time-tested process of research, development, and consultation. Half a century ago, Kitson proposed forming the cross-disciplinary science of "occupationology," which would draw from psychology, sociology, economics, education, and engineering (Kitson, 1944, as cited in Shartle, 1952). Perhaps in keeping with the time, Kitson's new science could be called "occupanomics" (from the Greek word nomikos, meaning law), which would serve as a molar counterpart to the established field of ergonomics. The multi-disciplinary reports and R and D efforts commissioned by DOL over the past few years could augur well for Kitson's envisionment. However, the lack of an adequate occupational taxonomic system will hinder advancement of occupanomics and all occupationally related scientific enterprise. The system proposed in this paper would provide a useful framework for linking science to the economic structure, thus better harnessing scientific efforts to practical work-force and economic development.

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APPENDIX A

21 Broad Numerical Occupational Clusters Based on OAI Descriptors (from Pass & Cunningham, 1977)

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1. Organizational and Human Relations Occupations
2. Clerical Occupations
3. Sales and Customer Service Occupations
4. Protective Services Occupations
5. Material/Product Handling, Inspecting, and Recording Occupations
6. Occupations in Applied Physical Science and Technology
7. Occupations in Electronic/Electrical Equipment/Systems Operation
8. Farming, Forestry, and Related Occupations
9. Health-Related Occupations
10. Personal Service Occupations
11. Occupations in the Performing Arts
12. Occupations in Visual Aesthetics
13. Occupations in Animal Care
14. Occupations in Assembly and Fabrication
15. Structural Work Occupations
16. Mechanics and Stationary Machine/Equipment Repairers and Operators
17. Occupations in Stationary Machine/Equipment Tending, Feeding, and Offbearing

Appendix A (continued)

18. Routine Object/Material Handling and Cleaning Occupations

19. Occupations in Mechanized Equipment and Vehicle Operation

20. Electricians, Electronic Technicians, and Related Occupations

21. Occupations in Food Processing/Preparation

APPENDIX B

21 Numerical Air Force Enlisted Job Clusters Based on GWI Descriptors

(from Ballentine, Cunningham, & Wimpee, 1992)

Cluster Titles and Specialty Examples		NJ	PMO	CC
1.	Electronic Systems Installation, Operation & Maintenance: Wideband Communications Equipment, Missile Electronic Equipment, Airborne Warning & Control Radar, Defensive Systems Trainer, Analog Flight Simulator	35	87	.98
2.	Mechanical Systems Maintenance: Aircrew Egress Systems, Aircraft Fuel Systems, Jet Engine, Tactical Aircraft, Helicopter, Airlift/Bombardment, Base Vehicle Equipment	18	62	.91
3.	Pavements/Utilities Construction & Maintenance: Cable Splicing Installation/Maintenance, Electrical Power Line, Pavements Maintenance	6	80	.93
4.	Structural Construction & Maintenance: Carpentry, Masonry	2	50	.90
5.	Environmental Equipment Maintenance: Missile Liquid Propellant Systems, Environmental Support	2	66	.71
6.	Aircrew Life Support Equipment Repair: Aircrew Life Support, Fabric & Parachute	2	100	.90
7.	Materials Forming & Shaping: Machinist, Metals Processing, Vehicle Body Mechanic, Packing	5	75	.95
8.	Audiovisual Equipment Operation & Maintenance: Audiovisual Media, Precision Imagery & Audiovisual Media Maintenance, Aerospace Photographic Systems	4	66	.82
9.	Information Production: Graphics, Still Photographic, Instructional Systems, Public Affairs	7	100	.96
10.	Band: Clarinet, Saxophone, Cornet or Trumpet, Instrumentalist	4	100	.97

Appendix B (continued)

	Cluster Titles and Specialty Examples	NJ	PMO	CC
11.	Flight Operations: Inflight Refueling, Flight Engineer, Air Traffic Control, Aerospace Control & Warning Systems	6	66	.87
12.	Aircrew Rescue & Recovery: Pararescue/Recovery, Seaman	2	100	.85
13.	Weather: Weather	2	100	.90
14.	Survey & Engineering: Geodetic, Engineering Assistant	3	66	.84
15.	Security & Fire Protection: Tactical Air Command & Control, Security, Law Enforcement, Fire Protection	7	100	.94
16.	General Administrative Management: Airfield Management, Maintenance Systems Analysis, Logistics Plans, Cost & Management Analysis, Operations Systems Management, Maintenance Scheduling, Financial Services, Personnel	28	74	.95
17.	Special Services Administration: Services,Recreation Services	3	66	.63
18.	Contract/Legal Services Administration: Contracting, Legal Services	3	66	.95
19.	Food Preparation & Management: Meatcutter, Diet Therapy, Food Service, Open Mess	6	100	.95
20.	Health Support Program Management: Drug & Alcohol Base Control, Mental Health, Aerospace Physiology	3	100	.90
21.	Medical/Dental Services: Aeromedical Service, Surgical Service, Radiology, Physical Therapy, Dental	7	100	.98
	Total:	155		
	Overall Value:		82	
	Mean:			.89

Note. A Level 5 (skilled specialist) job represented each specialty example unless otherwise noted. NJ = number of constituent jobs; PMO = percentage of membership overlap between subsample clusters; CC =correlation between subsample cluster centroids.

APPENDIX C

Occupational Clusters (Units) within Two OES 5-Digit Groups

1. OES Group 32502: Registered Nurses

Cluster 1: Nurse Supervisors

075.127-014	Nurse, Consultant
075.127-026	Nurse, Supervisor, Community-Health Nursing
075.127-030	Nurse, Supervisor, Evening-or-Night*
075.137-010	Nurse, Supervisor, Occupational Health Nursing
075.137-014	Nurse, Head
075.167-010	Nurse, Supervisor

Cluster 2: Nurses

075.264-010	Nurse, Practitioner*
075.264-014	Nurse-Midwife
075.364-010	Nurse, General Duty
075.371-010	Nurse, Anesthetist
075.374-014	Nurse, Office
075.374-018	Nurse, Private Duty
075.374-022	Nurse, Staff, Occupational Health Nursing
075.124-010	Nurse, School
075.124-014	Nurse, Staff, Community Health
075.127-034	Nurse, Infection Control

2. OES Group 55347: General Office Clerks

Cluster 1: Administrative Clerks

209.362-030	Congressional-District Clerk
219.362-010	Administrative Clerk*
219.362-022	Clerk, Telegraph Service
219.362-026	Contract Clerk, Automobile
375.362-010	Police Clerk
249.367-014	Career-Guidance Technician

Appendix C (continued)

Cluster 2: General Clerks

245.367-010	Animal-Hospital Clerk
245.367-014	Blood-Donor-Unit Assistant
245.367-018	Calendar-Control Clerk, Blood Bank
249.367-010	Animal-Shelter Clerk
209.562-010	Clerk, General*
243.362-014	Police Aide
245.362-014	Unit Clerk

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*Occupation selected as cluster "seed."

APPENDIX D[1]

Factors Derived from Occupations' USES Work Field and MPSMS Designations: An Exploratory Analysis (N = 12,375)

		Loading
Factor 1:	**Health Care**	
294	Healthcaring - Medical	.93
924, 925, 926, 929	Physician; Dental; Optician; Chiropractor	.73
921, 922, 923	Nursing; Dietetic	.62
Factor 2:	**Engineering & Architecture**	
700	Architecture & Engineering	.88
244	Engineering	.75
242	Drafting	.64
Factor 3:	**Legal Services**	
932	Legal Services	.94
272	Litigating	.94
Factor 4:	**Animal Care, Propagation & Harvesting**	
001, 002	Hunting - Fishing; Animal Propagation	.93
320, 330	Animals; Marine Life	.93
Factor 5:	**Protection & Regulation**	
950	Regulation, Protection, & Related Government Svc.	.81
293	Protecting	.74
271	Investigating	.56
Factor 6:	**Physical & Biological Sciences**	
251	Researching	.82
722, 723, 724, 725, 729	Astronomy; Chemistry; Physics; Geology	.66
732, 739	Biological Sciences; Life Sciences, n.e.c	.61
Factor 7:	**Teaching & Related Educational Services**	
931	Educational Services	.88
296	Teaching	.87
Factor 8:	**Crop, Horticultural, & Tree Propagation/Care**	
003	Planting; Cultivating	.88
300, 310	Plant Farm Crops; Horticultural Specialties; Forest Trees	.87

Appendix D (continued)

		Loading
Factor 9:	**Professional Writing**	
261	Writing	.87
757	Literature & Journalism	.86
Factor 10:	**Communication & Broadcasting Systems**	
861, 862, 869	Telephone Communication; Telegraph Communication;	.80
281	System Communicating	.79
863, 864	Radio Broadcasting; Television Broadcasting	.51
Factor 11:	**Electrical & Electronic Fabrication, Installation, & Repair**	
580	Electrical & Electronic Machinery, Equipment, Supplies	.86
111	Electrical - Electronic Fabricating - Installing - Repairing	.83
Factor 12:	**Accounting; Auditing; Bookkeeping; Record Keeping**	
232	Numerical Recording - Record Keeping	.84
892	Accounting, Auditing, & Bookkeeping Services	.83
Factor 13:	**Cooking & Food Beverage Preparation/Processing**	
146	Cooking - Food Preparing	.84
380, 390, 400	Food Staples & Related; Food Specialties; Tobacco Products	.80
Factor 14:	**Visual Arts & Photography**	
751, 752, 753	Fine Arts; Graphic Arts; Photography	.83
262	Artistic Painting - Drawing	.64
201, 202	Photographing; Developing - Printing	.47
Factor 15:	**Sales & Merchandising**	
292	Merchandising - Sales	.86
880	Merchandising Services	.84
Factor 16:	**Chemical Processing**	
141, 142, 143, 144, 145, 147	Baking - Drying; Crushing - Grinding; Mixing; Distilling; Separating; Processing - Compounding	.80
490, 500, 510	Chemical Products; Petroleum Products; Rubber & Plastic Products	.77
Factor 17:	**Transportation Services**	
850	Transportation Services	.85
013	Transporting	.83

Appendix D (continued)

		Loading
Factor 18:	**Personal, Domestic & Building Services**	
900	Domestic, Building, & Personal Services	.82
291	Accommodating	.80
Factor 19:	**Entertainment & Dramatic Arts**	
297	Entertaining	.78
911, 912, 919	Motion Picture Services; Theater Services, Amusement & Recreation Services	.77
754, 755	Dramatics; Rhythmics(Dancing)	.31
Factor 20:	**Counseling, Social, & Spiritual Services**	
298	Advising - Counseling	.81
940	Social, Employment, & Spiritual Services	.70
733, 744, 745	Psychology (Including Counseling); Sociology; Anthropology	.48
Factor 21:	**General Administration & Administrative Specialties**	
893	General Administrative Specialties	.86
233	Data Processing	.85
Factor 22:	**Clerical Services**	
231	Verbal Recording - Record Keeping	.78
891	Clerical Services (except Bookkeeping)	.77
282	Information Giving	.37
Factor 23:	**Apparel/Textile Product Fabrication & Repair**	
430, 440, 520	Textile Products; Apparel; Leather & Leather Products	.80
171	Sewing - Tailoring	.80
Factor 24:	**Textile Fiber & Fabric Production**	
161, 162, 163, 164, 165, 166	Combing - Napping; Spinning; Winding; Weaving; Knitting; Tufting	.82
410, 420	Textile Fibers; Fabrics & Related	.81
Factor 25:	**Music & Musical Choreography**	
263	Composing - Choreographing	.84
756	Music	.82
Factor 26:	**Structural Fabricating, Installing & Repairing**	
102	Structural Fabricating - Installing - Repairing	.68
590	Transportation Equipment	.65

Appendix D (continued)

		Loading
Factor 27:	**Public Utilities: Electric, Gas, Water, & Sanitary Services**	
870	Electric, Gas, & Sanitary Services	.83
014, 021	Pumping; Stationary Engineering	.82
Factor 28:	**Mechanical Fabrication, Installation & Repair**	
560	Machinery	.77
121	Mechanical Fabricating - Installing - Repairing	.57
Factor 29:	**Construction**	
360	Structures	.77
091, 092, 094, 095	Masoning; Laying-Covering; Caulking; Paving	.76
Factor 30:	**Mining, Quarrying, & Earth Boring**	
005	Mining - Quarrying - & Earth Boring	.81
340, 350	Raw Fuels & Nonmetallic Minerals; Raw Metallic Minerals	.77
Factor 31:	**Fusing/Cutting Metal with Heat**	
081, 082, 083	Welding; Flame Cutting -Arc Cutting - Beam Cutting Soldering - Brazing	.62
540	Metal, Ferrous & Nonferrous	.58
550	Fabricated Metal Products	.57
131, 132, 133, 134, 135, 136	Melting; Casting; Heat Conditioning; Pressing - Forging; Die Sizing; Molding	.30
Factor 32:	**Stock Keeping**	
897, 898, 899	Blueprinting, Photocopying, etc.; Stockchasing, Timekeeping, etc; General Business, n.e.c.	.79
221	Stock Checking	.58
Factor 33:	**Furniture Fabrication & Repair**	
101	Upholstering	.78
460	Furniture & Fixtures	.77
Factor 34:	**Administering**	
295	Administering	.64
895	Insurance & Real Estate	.53
Factor 35:	**Printing**	
191, 192	Printing; Imprinting	.69
480	Printed & Published Products	.67

Appendix D (continued)

		Loading
Factor 36:	**Decorating/Styling**	
759	Arts & Literature, n.e.c.	.75
264	Styling	.60
Factor 37:	**Working with Stone, Clay or Glass**	
530	Stone, Clay, & Glass Products	.78
051, 052	Abrading; Chipping	.47
Factor 38:	**Precision Material Shaping**	
053, 054, 055, 056, 057	Boring; Shearing - Shaving; Milling - Turning - Planing; Sawing; Machining	.71
241	Laying Out	.61
Factor 39:	**Library, Museum, & Archival Services**	
933, 939	Museum, Library, & Archival Services; Services, n.e.c.	.80
282	Information Giving	.31
Factor 40:	**Excavating, Clearing, & Material Moving**	
007	Excavating - Clearing - Foundation Building	.71
011	Material Moving	.67
Factor 41:	**Inspecting/Testing Products & Materials**	
212	Inspecting - Measuring - Testing	.71
041	Filling - Packing - Wrapping	.52
370	Ordinance	.33
Factor 42:	**Logging, Milling, & Finished Wood Production**	
004	Logging	.72
450	Lumber & Wood Products	.66
Factor 43:	**Precision Instrument Fabrication & Repair**	
600	Measuring, Analyzing, Controlling Instruments; Photographic; Medical; Optical Goods; Watches/Clocks	.72
Factor 44:	**Coating/Impregnating Materials**	
151, 152, 153, 154	Immersing - Coating; Saturating; Brushing - Spraying; Electroplating	.72
031, 032	Cleaning; Surface Finishing	.47

Appendix D (continued)

LoadingFactor 45:	**Etching & Engraving**	
182, 183	Etching; Engraving	.61
610	Miscellaneous Fabricated Products	.56
Factor 46: Assembling		
071, 072, 073	Bolting - Screwing; Nailing; Riveting	.65
061, 062, 063	Fitting - Folding; Fastening; Gluing - Laminating	.37
Factor 47: Economics & Finance		
741	Economics	.78
894	Financial Services	.59
Factor 48: Unnamed		
913	Sporting Services	.77
211	Appraising	.60
Factor 49: Unnamed		
731	Agriculture, Horticulture, Forestry Sciences	.70
243	Surveying	.68
Factor 50: Butchering/Meat Cutting		
034	Butchering - Meat Cutting	.77
Factor 51: Mathematics		
721	Mathematics	.79
Factor 52: History & Political Science		
742, 743	Political Science; History	.91

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[1]Carried out by two of the authors in collaboration with Ronald R. Boese.

APPENDIX E

Table 1 (from Cunningham & Scott, 1988; Scott, 1989)

USES Worker-Oriented Job Variable Clusters: Cluster Members and Their R-Square Values (N = 12,375)

Cluster and Variable Titles	R-Square
Cluster 1: Cognitive Activities	
GED Reasoning	.91
GED Language	.86
GED Math	.84
Data Function .83	
Specific Vocational Preparation	.82
General Intelligence	.81
Verbal Aptitude	.80
Numerical Aptitude	.75
Clerical Aptitude	.55
Repetition Temperament	(-).62[1]
Cluster 2: Skilled Motor Activities	
Things Function	.62
Coordination	.60
Finger Dexterity	.56
Manual Dexterity	.56
Precise Tolerance Temperament	.34
Cluster 3: Managerial Activities	
People Function	.81
People Temperament	.80
Talking/Hearing (Physical Demand)	.77
Direction Temperament	.72
Variety Temperament	.38
Cluster 4: Demanding Physical Activities	
Stooping, Kneeling, Crouching, Crawling	.68
Strength	.55
Climbing/Balancing	.48

Table 1 (continued)

	R-Square
Cluster 5: Skilled Social Activities	
Influencing Temperament	.52
Judgment Temperament	.52
Feeling Temperament	.16
Reaching (Physical Demand)	(-).55[1]
Cluster 6: Visual Perception	
Form Perception	.68
Spatial Aptitude	.64
Seeing (Physical Demand)	.45
Measurable Criteria Temperament	.44
Color Discrimination	.34
Cluster 7: Stress	
Stress Temperament	.62
Eye-Hand-Foot Coordination	.62

[1] = This variable's underlying relationship with its cluster is negative.

Table 2 (from Scott, 1989)

USES and OAI Worker-Oriented Job Variable Clusters: Cluster Members and Their R-Square Values (N = 1,034)

Cluster and Variable Titles	R-Square
Cluster 1: Cognitive Activities	
USES Variables	
GED Reasoning	.88
GED Language	.85
General Intelligence	.83
Verbal Aptitude	.83
GED Math	.81
Data Function	.78
Specific Vocational Preparation	.75
Numerical Aptitude	.72
OAI Variables	
G1: Responsibility & Incentives	.81
D10: Analyzing & Synthesizing Info.	.70
B1: Semantic Operations	.68
D1: Verbal Communication	.62
B3: Symbolic Operations	.45
Cluster 2: Clerical Activities	
USES Variables	
Clerical Aptitude	.57
OAI Variables	
D2: Clerical Activities	.78
F1: Business Related Numerical Objectives	.74
A2: Business Related Numerical & Written Info.	.72
F10: Editing, Proofing, & Clerical Objectives	.68
D11: Routine Recording	.68
B4: Routine Symbolic & Semantic Info. Process.	.64
D9: Mathematical/Computational Activities	.63
A11: Structure & Format of Written Information	.59
Cluster 3: Skilled Social Activities	
USES Variables	
People Temperament	.65
Talking/Hearing (Physical Demand)	.62
Influencing Temperament	.38
Judgment Temperament	.30

Table 2 (continued)

	R-Square
Cluster 3: Skilled Social Activities (continued)	
OAI Variables	
G12: Social Service Context	.65
E7: Obtaining & Giving Information	.57
E8: Persuading	.54
E3: Serving/Assisting	.47
Cluster 4: Managerial Activities	
USES Variables	
People Function	.64
Direction Temperament	.59
OAI Variables	
F8: Human Behavior Objectives	.74
E1: Organizing & Supervising Others	.68
F13: Organizational Performance Objectives	.55
A9: Info. Related to People & Human Behavior	.54
E2: Resolving Conflicts	.41
Cluster 5: Skilled Motor Activities	
USES Variables	
Motor Coordination	.70
Manual Dexterity	.69
Finger Dexterity	.69
Things Function	.61
OAI Variables	
K1: Controlled Arm, Hand, & Finger Activities	.43
Cluster 6: Figural Activities	
USES Variables	
Spatial Aptitude	.62
Form Perception	.47
Measurable Criteria Temperament	.25
OAI Variables	
A8: Spatial Information	.70
F5: Technical Planning/Drawing Objectives	.63
D3: Drafting/Drawing	.61
B2: Figural Operations	.49

Table 2 (continued)

Cluster 7: Demanding Physical Activities	
USES Variables	
Strength	.63
Stooping, Kneeling, Crouching, Crawling	.59
Climbing/Balancing	.35
OAI Variables	
K2: Dynamic Strength/Endurance	.52
K7: Static Strength	.50
K8: Climbing & Other Knee/Back-Bending Activities	.35

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MAPPING WORKFORCE SKILLS

Designing the Future SOC to Help American Workers

June 1995

Daniel Flaming and Odessa Dubinsky

Economic Roundtable
315 W. Ninth St., Suite 310
Los Angeles, CA 90015
213-892-8104

The authors accept all responsibility for the accuracy of the contents of this paper, and for all opinions that are expressed. There should be no presumption that these views are shared by anyone affiliated with the sponsoring agency, the Department of Labor.

MAPPING WORKFORCE SKILLS

Daniel Flaming and Odessa Dubinsky
Economic Roundtable

Executive Summary

Occupational Information in the Context of National Priorities

Access to opportunity for America's working men and women is determined by the quality of their skills and the chances they are given to improve those skills. The *Report on the American Workforce* recently released by the Department of Labor convincingly describes "a workforce composed of three groups one with strong skills getting sharper, one with less developed skills that are rapidly losing their edge, and another with virtually no marketable skills at all." It concludes, "nothing is more vital to fulfilling our national ideals than equipping all Americans with the knowledge, skills, and abilities needed to lead meaningful, productive working lives."

Worker skills are at the heart of profound changes occurring in the labor market. The Department of Labor report states, "Occupations that have shown the most rapid growth over the past decade are those with relatively high requirements in terms of formal education, specific knowledge, and training. In contrast, some of the occupations requiring relatively low levels of formal education have either become declining in size or have shown little growth in recent decades. Projections of future employment developments envisage further movement in that direction."

American workers and employers are making massive investments and efforts to acquire skills that are essential for continued employment and competitive businesses. The Department of Labor report notes that, "in 1991, almost 65.3 million people or 57 percent of those employed said they needed specific skills to qualify for their jobs, up from 55 percent in 1983. The proportion of workers who said they took training to improve their job skills rose from 35 percent in 1983 to 41 percent in 1991."

America's interest in a competitively skilled workforce should be supported by the future Standard Occupational Classification System. It should be the central information resource for mapping existing workforce skills and areas in which new skills are required for changing and emerging occupations. To achieve this end, insights of knowledgeable users of occupational information should be used to redesign and integrate current systems to create strengthened capabilities for identifying skills workers need to obtain specific jobs, as well as jobs they might obtain based on skills they already possess.

Direct and Indirect Users of Occupational Information

A key question in designing the future Standard Occupational Classification system is how needs and insights of the relatively small group of users who understand tools of occupational analysis, but whose vision of change rarely extends more than one step beyond the systems they have experienced, can be used to reshape a domain of information that is critically important for an issue at the heart of the nation's domestic agenda full employment and optimal use of skills for American workers.

It is useful to think of consumers of occupational information in terms of both "Direct" and "Indirect" Users. Direct Users include the employment service staffs, the Department of Labor, educational institutions, rehabilitation counselors, economic analysts, businesses, and librarians.

Indirect Users include all those who are or should be beneficiaries of occupational classification systems. Benefit comes to Indirect Users by application of the data to the solution of their employment problems and life choices.

It is essential that wants and needs of both groups of users be explored and evaluated honestly. The classification data component requirements are similar to those of the financial tables of the stock market they must be accurate, current, and subject to constant oversight for inclusion and exclusion of required data to protect their validity and credibility. Far too many government statistics are no longer used by some economists because they doubt their accuracy and credibility.

This paper is based on three assessments concerning the adequacy of currently identified user groups for defining public priorities to be served by the future SOC.

1. Occupational classification data is not an end in itself. It is a tool for obtaining answers to questions and solutions to problems that are important for aiding and improving working conditions of our society. The views of current users are valuable to the extent that they competently identify what occupational information is needed and how it should be used to address labor force issues.

2. Not all users are equally insightful. It appears that only 54% of respondents to previous surveys were individuals who consult an occupational classification system even once a week (Westat, 1993, p. 4-3). This suggests that some organizations being surveyed may have been marginal users of occupational classification information, given the likelihood that organizations receiving previous surveys routed them to the individual in the organization most knowledgeable about occupational classification issues.

3. The SOC does not have an identifiable constituency of users. Its primary use is for identifying crosswalks between other systems. It offers no independent classification definitions or data. Consequently, it makes more sense to view it as an opportunity for

a system yet to be created rather than a system with an existing constituency.

Survey of Labor Market Experts

To probe beyond boundaries of previous surveys, the Economic Roundtable initiated and sponsored an independent survey of expert users in 1993, to obtain views from highly knowledgeable individuals who use occupational information for employment and training programs and research, as well as labor organizers and personnel administrators in business who have informed perspectives and deal with workforce issues that should be illuminated by national occupation information. This survey focussed specifically on the relationship between the societal goals identified as important by individuals and the information they believe is needed in a revised system. To the best knowledge of the authors, this is the only survey that has investigated user views about the public interests (i.e., needs of Indirect Users) that should be served by occupational classification information.

Conclusions from Economic Roundtable Survey

A wide net was cast to draw on the insights and opinions of expert individuals in diverse positions with rather different approaches to the potential use of an occupational classification system. Despite some diversity in origin, they share a remarkably strong consensus on the necessary information that an occupational classification system should contain, and the major problems currently experienced by users. There appears to be broad user support for changes that would transform the SOC into a classification system:

> that can help unemployed workers find new jobs that will utilize their skills as well as provide current labor market information;
>
> in which the most important classification variables are skill measurements;
>
> that provides information about tasks performed in occupations and industries that use each occupation; and
>
> in which information is up-to-date and accurate.

The primary use envisioned for the future system by users is to provide information useful to workers in their search for employment. By improving the quality and accessibility of information available to workers, and to those such as counselors who assist in matching workers with jobs, a broader social interest is enhanced. The most important kind of occupational information for supporting this end concerns skill transferability. Users place high priority on an accurate, up-to-date system with specific information that will offer workers:

1. A common language for enumerating the skills they possess.

2. An effective system for identifying jobs which require their combination of skills.

Fully Integrated, "Real Time" Information

The area in which user responses are least helpful is envisioning the architecture and capabilities of a system that is many steps beyond that with which they are already familiar. A new system that integrates multiple sources of data will have information outcomes and applications that have not been seen before and can transform the role of occupational information in serving workers. The possibilities for a classification system that fully integrates DOT, OES, Census, and public employment service data are not recognized by a majority of respondents only 26% gave high priority, and another 42% medium priority, to integrating occupational and social information in the Economic Roundtable survey.

Issues of system architecture such as data integration and real-time information that are far removed from the actual experience of current users and difficult to visualize appear to be an area in which the needs of Indirect Users should take precedence over priorities expressed by Direct Users.

A potential strength of the new SOC is its capacity to fully integrate the wealth of occupational information collected by job analysis with the employment statistics and demographic information collected through OES surveys and the Census. An uncomplicated and widely accepted occupational classification which simplifies and aids the connection among these data sources will have a synergistic effect in increasing the power of the information.

A new SOC that supports integration of data from multiple sources should also have built-in capabilities for improving the integrity and labor market-relevance of its own classification structure by identifying cross-occupational linkages that indicate transferability of skills or experience.

Conclusion

A primary test of the usefulness of occupational information is its power to provide accurate, grounded insights that actually improve labor market outcomes for workers. Important public interests rest on the capacity of the future SOC to provide occupational information that is responsive to the needs of both Direct and Indirect Users. The preliminary assessment of Direct and Indirect Users presented in this paper suggests that in order for the future SOC to respond to their real wants and it should be designed to:

1. Serve the needs not only of Direct Users, but also Indirect Users, who are the intended beneficiaries of the public investment in producing occupational information.

2. Provide information that is tangibly helpful for achieving the highest priority societal interest for occupational information identified by all user groups, namely helping workers who need jobs become employed.

3. Use a classification system based on worker skills.

4. Provide current, accurate information, including descriptions of essential skills and competencies, tasks performed, and industries in which occupations are found.

5. Support projections of future employment.

6. Fully integrate all publicly produced employment information about workers and occupations, including occupational classification data from the DOT, industry employment data from the OES, worker demographic information from the Census, and earnings and employment data from the public employment services.

Occupational Information in the Context of National Priorities

There is an opportunity for the future Standard Occupational Classification system to transform the quality and types of information available to users by building on newly emerging information technologies and directing the interest of national policy makers toward integrating and restructuring current systems. This prospect is more than an incremental change in classification methodology; it represents a possible renascence in labor market information. A key question in designing this new system is how needs and insights of the relatively small group of users who understand tools of occupational analysis, but whose vision of change rarely extends more than one step beyond the systems they have experienced, can be used to reshape a domain of information that is critically important for an issue at the heart of the nation's domestic agenda full employment and optimal use of skills for American workers.

The *Report on the American Workforce* recently released by the Department of Labor offers convincing evidence that access to opportunity for America's working men and women is determined by the quality of their skills and the chances they are given to improve those skills. The report describes "a workforce composed of three groups one with strong skills getting sharper, one with less developed skills that are rapidly losing their edge, and another with virtually no marketable skills at all." It concludes, "nothing is more vital to fulfilling our national ideals than equipping all Americans with the knowledge, skills, and abilities needed to lead meaningful, productive working lives."[1]

Worker skills are at the heart of profound changes occurring in the labor market:

> Occupations that have shown the most rapid growth over the past decade are those with relatively high requirements in terms of formal education, specific knowledge, and training. In contrast, some of the occupations requiring relatively low levels of formal education have either become declining in size or have shown little growth in recent decades. Projections of future employment developments envisage further movement in that direction.[2]

American workers and employers are making massive investments and efforts to acquire skills that are essential for continued employment and competitive businesses:

> In 1991, almost 65.3 million people or 57 percent of those employed said they needed specific skills to qualify for their jobs, up from 55 percent in 1983. The proportion of

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[1] U.S. Department of Labor, *Report on the American Workforce*, 1994, pp. 1-2.

[2] Ibid, p. 28.

workers who said they took training to improve their job skills rose from 35 percent in 1983 to 41 percent in 1991.[3]

The future Standard Occupational Classification Systems should be the central national information resource for mapping existing workforce skills and new skills required for changing and emerging occupations. To achieve this end, insights of knowledgeable users of occupational information should be used to redesign and integrate current systems to create strengthen capabilities for identifying skills workers need to obtain specific jobs, as well as jobs they might obtain based on skills they already possess.

Important questions in deciding how to draw on the insights and priorities of expert individuals who use occupational information on behalf of workers are: What are the core needs of current users that the future system should be designed to serve more effectively? What are the needs of the larger universe of potential users who could benefit from improved occupational information but have little or no connection with current systems? And, in what way should user priorities be allowed to shape a future system that they do not now envision because it may well be an order of magnitude more powerful than current systems in terms of richness, timeliness and accuracy of data, and capability for fully integrating a wide range of data sources applicable to workers and the labor market?

Public information has value when it is wanted and used by, and useful for, a reasonably large and broad-based body of users. The value of an occupational classification system is found in its acceptance and application by its users and in the extent to which benefits for workers are derived from its use.

Uses and Users of the New SOC

Efforts to distinguish and enumerate the actual and potential users of the existing occupational classification systems, i.e, the DOT, SOC, and OES, have met with limited success.[4] Much research has been through the accounting of buyers of system manuals, although, according to Dr. Alan Moss, no records have been kept of customers purchasing the SOC manual.

The authors of "Work, Jobs, and Occupations" made very extensive efforts to collect data on DOT users outside the employment services, both federal and state, which are provided with copies of the manual on publication. They found that institutional buyers - primarily federal agencies and educational institutions - brought many copies in bulk which ostensibly were distributed to relevant staff. Records were also available for direct sales to individuals and for bulk orders from government book stores and college text book distribution firms. This study was carried out for a one-year period following the publication of the fourth edition of the DOT in December 1977.[5]

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[3] Ibid, p. 81.

[4] "Consumer Criteria for the Next Standard Occupational Classification System," Allan Moss, Ph.D., Department of Labor Paper, 1993.

This survey indicated that, of the non-Labor Department distribution, educational institutions purchased 42% of all the manuals sold, with other government agencies, e.g., the Army, Navy, Social Security Administration, buying another 20%. Libraries took 13%, private for-profit businesses 14%, and non-profit organizations (probably research, private counseling, and job training and placement agencies) took 10%. It might be noted that while the Navy was given copies by the Department of Defense, they were immediately warehoused and evidently not used. The types of work performed by purchasers were largely concentrated in career or vocational counseling, librarianship, and management/compensation.

Dr. Moss identifies probable customers for an expanded SOC as the "vital few," the "useful many," and the "workforce." The "vital few" represent the constituency which has expert knowledge of the occupational classification systems. The "useful many" concerns mostly professionals in counseling or placement, who develop labor market information or conduct planning or research into subjects which require occupational data. The "workforce" encompasses consumer experts --those who practice occupational analysis, or prepare tools and products of occupational classification.

Building on Dr. Moss's user categories, another grouping that is useful for thinking about the future SOC is "Direct" and "Indirect" Users. Direct Users fall into the three groupings noted above. They are the employment service staffs and the Department of Labor divisions such as the Bureau of Labor Statistics and other units directly involved in almost any aspect of labor market information. These Direct Users provide technical support to the field and to other government agencies such as the Bureau of the Census, and the Department of Commerce.

The Direct Users group also includes staff of educational institutions who provide vocational guidance and counseling, develop and prepare vocational and academic training courses, and plan educational programs leading to preparing students for the world of work. In addition, developers of career and occupational guidance systems have been major users and appliers of occupational information, and rely heavily on the job definitions and worker traits in the DOT, the groupings provided by the SOC, and all occupational labor market information provided by government agencies.

Rehabilitation counselors are regular users of occupational classification system data, especially those relating to worker traits which emphasize the ability of their clientele to obtain work. The Social Security Administration claims determination workers are mandated to use the DOT, and undoubtedly the new SOC, when available, in making decisions on benefits.

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[5] "Work, Jobs, and Occupations: A Critical Review of the DOT," pp. 46 and ff, 1980.

Businesses may, or should, use accepted and standardized occupational classification systems for classifying their employees, determining the validity of their own job and work requirements, planning the organizational structure of firms, and helping set up wage and salary standards by occupation. Librarians, while not exactly Direct Users, must know about and do provide the information to other Direct Users.

Economic analysts and researchers, while relatively few in number, are very intensive Direct Users. They must rely on certain of the data to make knowledgeable forecasts and to "read" the labor market when analyzing issues related to employment outcomes and labor market trends.

Indirect Users include all those who are or should be beneficiaries of occupational classification systems. The benefit and "profit" comes to Indirect Users by application of the data to the solution of their employment problems and life choices.

The Indirect Users are students, job seekers, new entrants to the labor market, and those wanting to change or improve their job situation. Occupational information, as interpreted to Indirect Users by Direct Users, can help in portraying the work place both realistically and literally. The Indirect User can be aided in finding a job opening, choosing a career path, or understanding what a job entails in the way of physical and mental demands, years of schooling, training, and experience.

Workers recently laid off, or in search of a first job, may be shown the width and breadth of the job market; how jobs are related by skills, and the potential and probability of their finding a job that is satisfying both financially and personally.

While the number and types of Direct Users are definitely restricted to the rather special few, the number and types of Indirect Users are limited only by the size and structure of the labor force plus those outside the labor force who want in. It is essential, therefore, that wants and needs of both groups of users be explored and evaluated honestly. The classification data component requirements are similar to those of the financial tables of the stock market they must be accurate, current, and subject to constant oversight for inclusion and exclusion of required data to protect their validity and credibility. Far too many government statistics are no longer used by some economists because they doubt their accuracy and credibility.

Surveys and analyses of occupational information users conducted since 1980 include:

The critical review by the National Academy of Science (1980).

An analysis by Michael D. Dymmel (Aguirre International) of responses to a concept paper published in the *Federal Register* (1992).

A survey of over 2,609 users, with 1,722 respondents, by Westat, Inc. (1993).

A summary of user needs and wants prepared by Ruth Hoppe, Utah Occupational Analysis Field Center (1994).

These surveys and analyses provide a valuable overview of the current role of the existing SOC/DOT system and the range of user needs. It is possible, however, to read these studies and come away with the impression that users of existing systems represent the universe of users interests that should be satisfied by a new occupational classification system.

This paper is based on three assessments concerning the adequacy of currently identified user groups for defining public priorities to be served by the future SOC.

1. Occupational classification data is not an end in itself. It is a tool for obtaining answers to questions and solutions to problems that are important for aiding and improving working conditions of our society. The views of current users are valuable to the extent that they competently identify what occupational information is needed and how it should be used to address labor force issues.

2. Not all users are equally insightful. It appears that only 54% of respondents to previous surveys were individuals who consult an occupational classification system even once a week (Westat, 1993, p. 4-3). This suggests that some organizations being surveyed may have been marginal users of occupational classification information, given the likelihood that organizations receiving previous surveys routed them to the individual in the organization most knowledgeable about occupational classification issues.

3. The SOC does not have an identifiable constituency of users. Its primary use is for identifying crosswalks between other systems. It offers no independent classification definitions or data. Consequently, it makes more sense to view it as an opportunity for a system yet to be created rather than a system with an existing constituency.

The view of the authors is that the SOC does not need to be revised to satisfy a stable set of user requirements, but rather to become a better and more relevant tool for a workforce and economy that are severely challenged and undergoing rapid change. Public programs related to worker training and job placement, which are important users of occupational classification data, are viewed critically in many quarters and may well be subject to fundamental restructuring as a result of national policy changes now being considered. Therefore, in designing a new SOC, the need is not to fit a stable pattern of existing uses but to assist current and new Direct Users, and a broadly defined constituency of Indirect Users, in achieving public interests related to an economically self-sufficient and globally competitive workforce.

Survey of Labor Market Experts

To probe beyond boundaries of previous surveys, the Economic Roundtable initiated and sponsored an independent survey of expert users in 1993. The purpose was to obtain views from highly knowledgeable individuals who use occupational information for employment and training programs and research, as well as labor organizers and personnel administrators in business who have informed perspectives about employment issues that should be illuminated by national occupation information. This survey focussed specifically on the relationship between the societal goals identified as important by individuals and the information they believe is needed in a revised system. A copy of the survey instrument can be found at the end of this paper. To the knowledge of the authors, this is the only survey that has investigated user views about the public interests (i.e., needs of Indirect Users) that should be served by an occupational classification information system.

Consistent with our emphasis on the societal purposes of the occupational classification system, inquiries were made of individuals who assist workers through counseling, education, job placement, labor union organizing, and other worker-centered activities. Our focus was also on individuals such as researchers and employees in state agencies who have a wide-ranging and inclusive understanding of the labor market and the role of occupational information in helping job seekers. By focussing on these groups, and contacting knowledgeable informants, it was possible to obtain incisive and thoughtful comments about issues that are central to this paper, but outside the scope of other surveys that have been conducted. Views and insights were obtained from sixty-six individuals through this independent survey to explore the concerns of potential users and to identify interrelationships between individuals' social priorities and the kinds of classification information they think are most important.

Profile of Respondents

Respondents to the survey came from all parts of the United States. Their institutional affiliations, duties, familiarity with classification system, and use of specific systems are profiled in Table 1 and Graph 1.

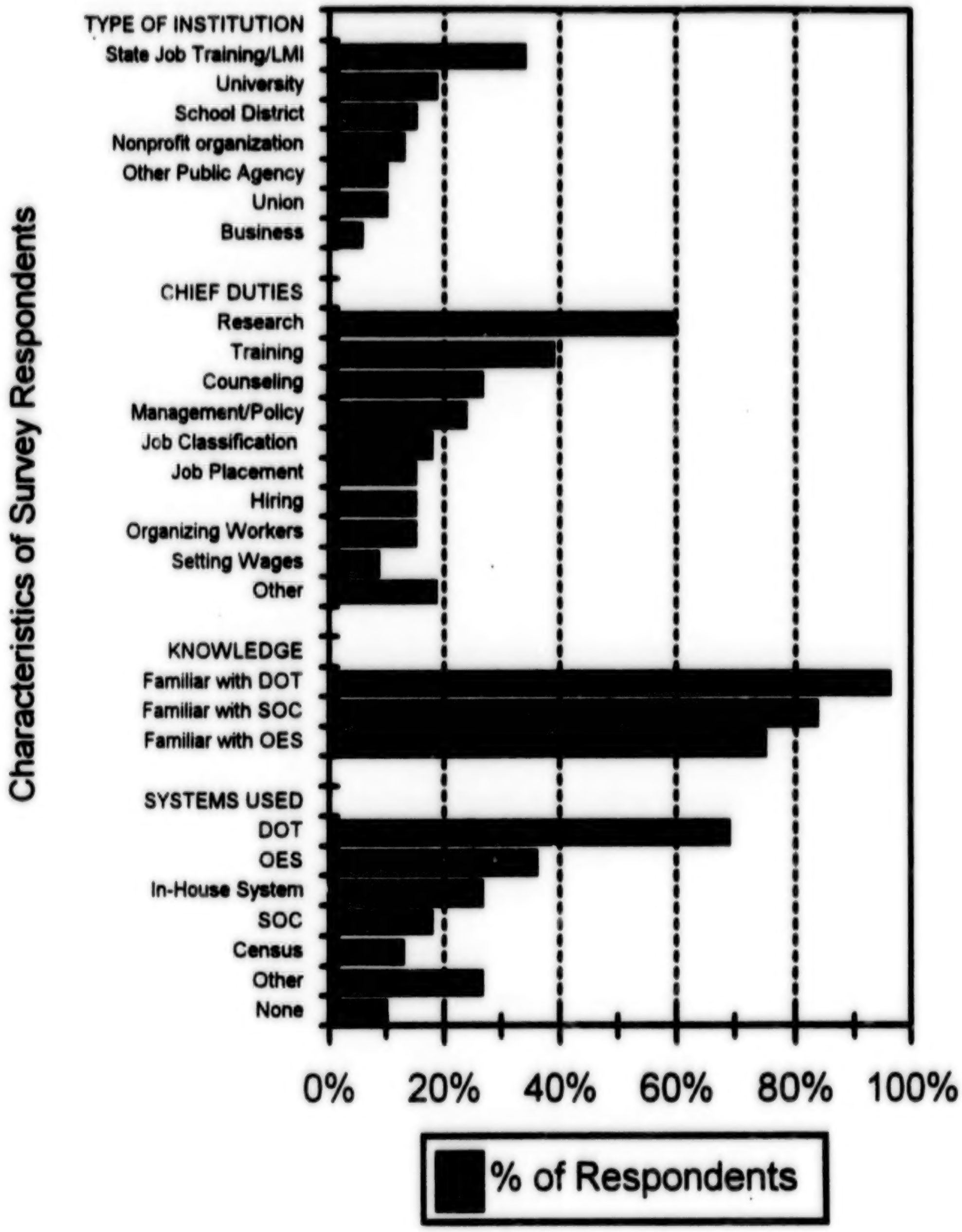
TABLE 1

USER CHARACTERISTICS

1993 Survey of Labor Market Experts

USER INFORMATION	TOTAL	PERCENTAGES
Respondents Completing Survey	66	100%
TYPE OF INSTITUTION		
State Job Training and/or LMI	22	33%
University	12	18%
School District	9	14%
Nonprofit Organization	8	12%
Other Public Agency	6	9%
Union	6	9%
Business	3	5%
CHIEF DUTIES		
Research	39	59%
Training	25	38%
Counseling	17	26%
Management and/or Policy Development	15	23%
Human Resource Activities	11	17%
Job Placement	9	14%
Hiring	9	14%
Organizing Workers	9	14%
Setting wages	5	8%
Other	12	18%
KNOWLEDGE OF OCCUPATIONAL CLASSIFICATION SYSTEMS		
Familiar with DOT	63	96%
Familiar with SOC	55	83%
Familiar with OES	49	74%
OCCUPATIONAL CLASSIFICATION SYSTEM(S) USED		
Use in-house system	17	26%
Use DOT	45	68%
Use OES	23	35%
Use SOC	11	17%
Use Census	8	12%
Use Other	17	26%
Use None	6	9%

Note: Some users reported more than one duty and use of more than one occupational classification system.



USER CHARACTERISTICS - GRAPH 1

1993 Survey of Labor Market Experts

Problems with Occupational Classification Systems

The survey asked respondents to indicate the kinds of problems they experience in using current occupational classification systems. The most common problem in using occupational classification systems, cited by over half the individuals surveyed, was that the information was out of date. In the words of one respondent,

> *The DOT is not based on a well-designed sample of employers. Most occupations probably have not been surveyed in years . . . . The entire DOT system, particularly the way in which the data are collected, is (as far as I can see) in disarray.*

Another respondent said,

> *Jobs have changed over the years. Update and list jobs as they are today.*

The next most common complaint, cited by almost a third of the individuals contacted, was that the system does not accurately describe jobs. One respondent commented,

> *None of the classification systems can adequately reflect or capture emerging technologies and industries. We need a complete, comprehensive data base with information that enables users to download what they need when they need it. To adequately reflect what the labor market is like, some information needs to be based on traditional occupational definitions (e.g., taxi drivers), some on industry association (e.g., some of the opportunities in health care), and some on changes in technology (e.g., materials fabrication, toxic waste cleanup).*

Another third of the individuals indicated that there are too many job definitions. Other significant concerns were that jobs were not grouped together appropriately, and that important information is missing. Some specific deficiencies were noted, for example,

> *The current DOT does not have enough categories for all kinds of social service and nonprofit jobs, but has too many agricultural and manufacturing jobs.*

These responses can be understood as reflecting two levels of reaction to the existing occupational classification system. At the first (and most common) level, individuals encounter concrete difficulties when trying to locate or define an occupation, and experience frustration at the out-of-date information, inaccurate job definitions, and lacking information. At the second level, individuals reflect on the limitations of the system and consider ways in which their frustration is related to system design; hence complaints about the number of job definitions and the grouping of jobs.

The survey also requested respondents to complete an open-ended question by describing the kinds of occupational information that would improve their ability to do their work. Three closely ranked priorities were: First, better information about skill and certification requirements for jobs. Second, up-to-date, accurate, specific information about jobs. And, third, an integrated system that links worker, industry, and demographic data. Responses to both of these questions are profiled in Table 2 and Graph 2.

TABLE 2

PROBLEMS AND NEEDED IMPROVEMENTS

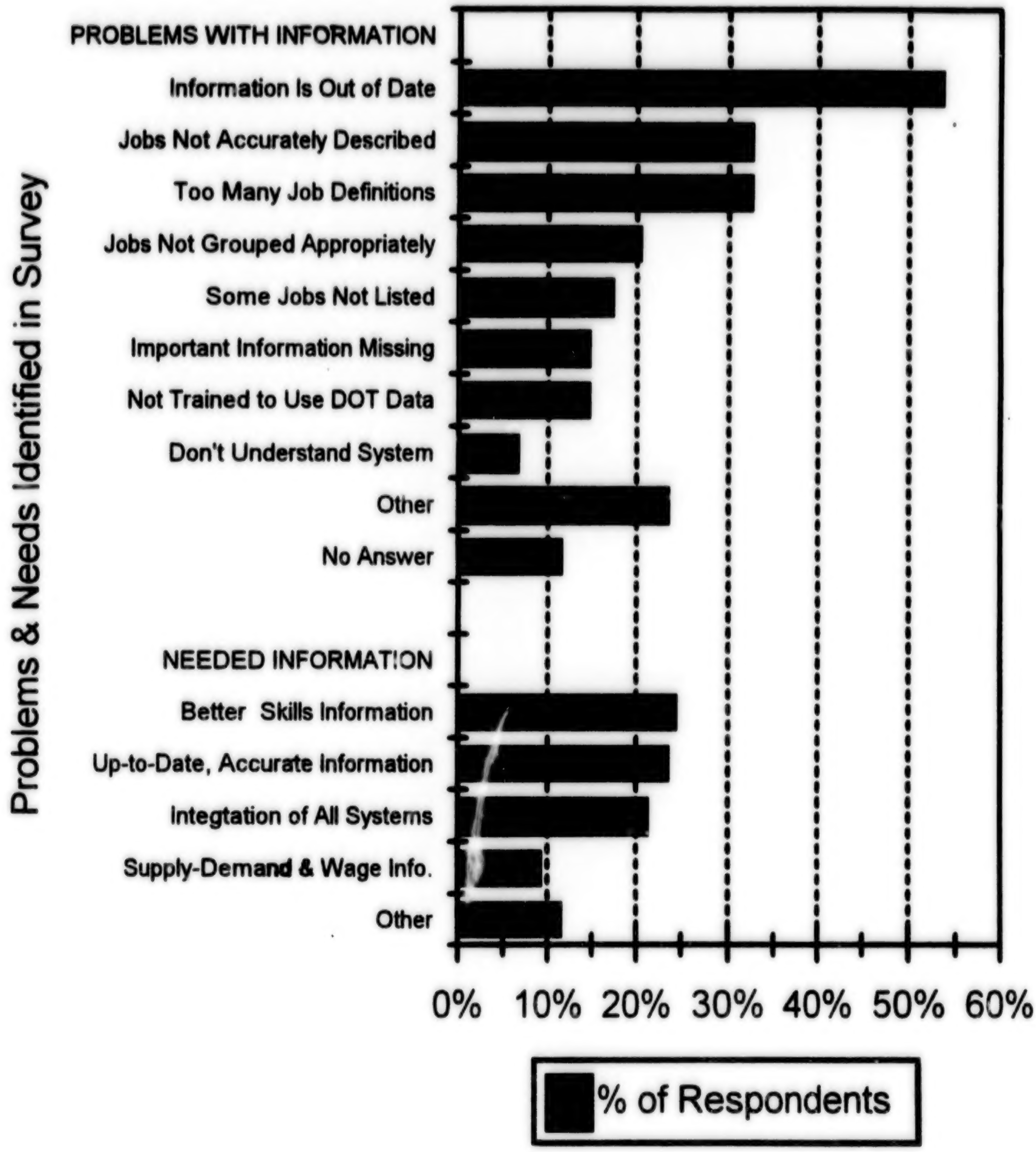
1993 Survey of Labor Market Experts

PROBLEMS EXPERIENCED USING OCCUPATIONAL INFORMATION		
Information is out of date	35	53%
Does not accurately describe jobs	21	32%
Too many job definitions	21	32%
Jobs not grouped together appropriately	13	20%
Does not list some jobs	11	17%
Important information is missing	9	14%
Not trained to use DOT codes/traits data	9	14%
Don't understand the system	4	6%
Other	15	23%
No Answer	7	11%

NEEDED INFORMATION (open-ended question)		
Better information about skill/certification requirements	16	24%
Up-to-date, accurate, specific information about jobs	15	23%
An integrated system that links worker, industry, demographic data	14	21%
Accurate supply-demand and wage or salary information	7	9%
Other	7	11%

PROBLEMS AND NEEDS - GRAPH 2

1993 Survey of Labor Market Experts



Societal Objectives for Occupational Information

The survey asked respondents, "What do you think are the highest priority needs that should be served by a new national standardized occupational information system?" A strong consensus emerged on the relative importance of some of the societal goals identified, while others evoked a greater diversity of responses. Informants overwhelmingly agreed that it is important to identify essential skills and competencies workers need to be job-ready and employer-acceptable, and to help displaced workers transfer their skills to new jobs. These two objectives of skill identification and skill transference were affirmed by over three-quarters of the informants. This finding is consistent with a survey of DOT users that found 58% considered skills transferability between occupations very important (Westat, 1993, p. 5-1). Commenting on the kinds of help needed by displaced workers one respondent said,

> *Work must be done to integrate emerging job requirements with satisfactory information systems which can [link emerging jobs] to the skills and abilities of current workers who may be in a completely different industry.*

Another respondent asked for,

> *Better format for definition clustering it should be easier to set up a system for identifying transferable skills . . . . We need more precise definition of SVPs, more information on requirements for general knowledge versus special knowledge requirements, and minimum skill standards.*

Another respondent asked for,

> *More realistic clustering of similar jobs so that true skill transferability is possible, not just aptitude transferability.*

Another respondent commented,

> *. . . A redesign is badly needed, particularly with regard to identifying unique combinations of skills required in job performance . . .*

Another respondent said,

> *Jobs should be classified according to skills and skill levels rather than functions.*

A similar request from another respondent was,

> *Less task, more about cognitive abilities and transferability.*

And another respondent asked for,

> *Better information on skill distinctions, especially for manual jobs.*

One respondent with a dissenting view about skill information said,

> *Put more focus on the general personal attributes required in different occupations and industries, rather than on specific job skills, e.g., responsibility, adaptability, motivation, cooperativeness the attitude dimension rather than specific mechanical skills and requirements that are either obvious or readily acquired on the job.*

Respondents also showed a strong desire for an occupational information system that provides reliable, current labor market information, with nearly two-thirds giving this a high priority. In the words of one,

> *We need access to trends in an easily decipherable form. What's growing? What's shrinking?*

This issue is closely related to interest in reliable projections of future employment, and so not surprisingly, this also received a high priority rating by over half the informants. One respondent asked for,

> *Accurate supply-demand and wage information based on more specific job descriptions.*

Opinions were gathered on research uses for the system, including integrating social and occupational information, doing historical analysis, making comparisons with other countries, and investigating work-related health problems. However, these were not as popular as projecting employment, with one quarter or more of the respondents rating them as low priority.

Over half of the individuals responding indicated that helping workers make successful job and career choices was only a medium priority, although relatively few indicated it was unimportant. There was more disagreement about helping workers identify career advancement opportunities, with a strong divergence of opinion about the importance of this activity. A similar pattern of mixed responses was received with regard to the issue of helping people overcome barriers to employment. Responses concerning the highest priority needs that should be served by a new national standardized occupational information system are shown in Table 3 and Graph 3.

TABLE 3
PUBLIC NEEDS THAT SHOULD BE SERVED BY NEW SYSTEM

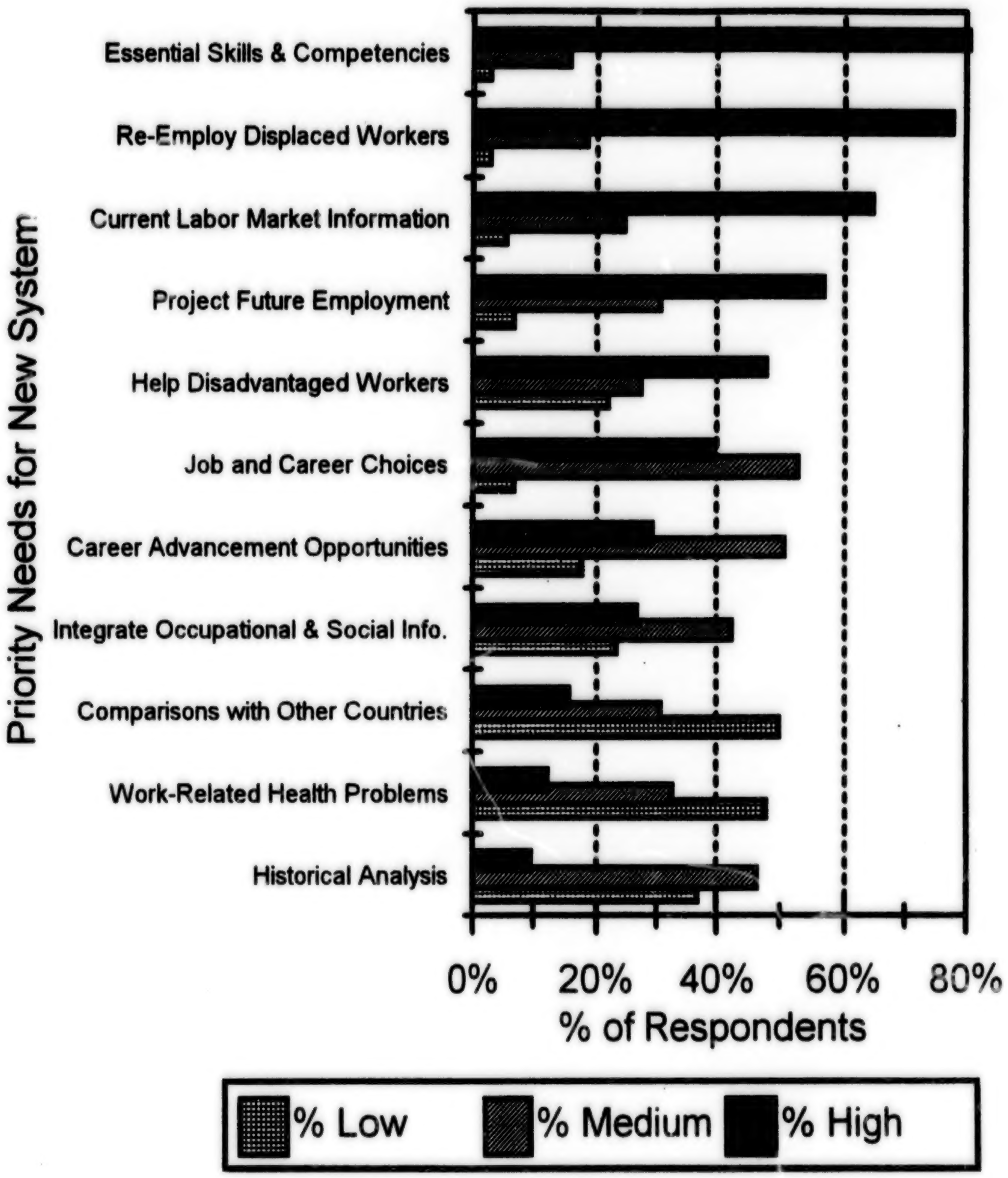
1993 Survey of Labor Market Experts

PRIORITY NEEDS FOR NEW SYSTEM	*Ratings by Survey Respondents*		
		Number	***Percent***
Identify essential skills and competencies	high	53	80%
	medium	10	15%
	low	1	2%
Help displaced workers transfer skills	high	51	77%
	medium	12	18%
	low	1	2%
Provide current labor market information	high	42	64%
	medium	16	24%
	low	3	5%
Support projection of future employment	high	37	56%
	medium	20	30%
	low	4	6%
Help people with barriers to employment	high	31	47%
	medium	18	27%
	low	14	21%
Help workers make job and career choices	high	26	39%
	medium	34	52%
	low	4	6%
Identify career advancement opportunities	high	19	29%
	medium	33	50%
	low	11	17%
Integrate occupational and social information	high	17	26%
	medium	28	42%
	low	15	23%
Enable comparisons with other countries	high	10	15%
	medium	20	30%
	low	32	49%
Support investigation of work-related health problems	high	8	12%
	medium	21	32%
	low	31	47%
Support historical analysis	high	6	9%
	medium	30	46%
	low	24	36%
Other	high	5	8%
	medium	2	3%
	low	0	0%
No answer		0	0%

Percentages are calculated based on 66 respondents.

NEEDS NEW SYSTEM SHOULD SERVE-GRAPH 3

1993 Survey of Labor Market Experts



Necessary Information Identified By Users and Potential Users

The survey explored the kinds of information users need by asking, "What kinds of information do you think it is most important to have about jobs?" An overwhelming consensus emerged regarding the priority of *skill requirements* as a central element in an occupational classification system, with 94% of informants indicating that this is of great importance. This was followed in magnitude by descriptions of tasks performed, which over three-quarters of the informants indicated was of great importance. The third most significant item was information about which industries use specific occupations, which nearly two-thirds of the informants indicated was important. This is consistent with the finding in the DOT user survey where 76% rated basic skills required as very important, and 79% regarded information on the duties and tasks performed as very important (Westat, 1993, p. 7-2). Table 4 and Graph 4 show how users rank the importance of different kinds of occupational information.

Some specific suggestions were made about how to improve measurement of skill. One person called for GED (General Educational Development) scores with a "critical thinking" breakout, and SVP (Specific Vocational Preparation) scores with a breakout to include both formal education and training, plus on-the-job training and length of time. Others pointed to the need for information on actual certification requirements, as well as abstract summaries such as SVP. This would include licensing, registration, accreditation standards, and typical educational qualifications required, such as a high school diploma or a bachelor or better degree. Findings from a survey of DOT users (Westat, 1993) indicate that a majority believe changing the SVP code to a measure of hours of preparation and replacing the GED code with a listing of the actual technical knowledge required to be "very" or "moderately important."

Drawing on a factor analysis of the fourth edition DOT produced by the 1980 critical review of the DOT (National Research Council, 1980), the subject areas of motor skills, physical demands, management skills, interpersonal skills, and working conditions were identified as distinct from each other and from the subject area of substantive complexity or skills. On the whole, most informants believed that motor skills such as dexterity, physical requirements such as lifting, management requirements such as planning ability, and working conditions such as heat, were of medium importance. These findings are echoed in part in the DOT user survey which found that the rating of "very important" was assigned to physical requirements by 51% and to working conditions by 48% (Westat, 1993, p. 3-6, 3-7).

There was rather more diversity of opinion regarding the importance of information about interpersonal skills such as tact, organizational context of jobs such as firm size or level of unionization, and mobility potential or "lattice" career movement. In these three cases, assessments of the importance of these types of information ranged from low to high, with no single assessment of importance being supported by a majority of informants. The DOT user survey (Westat, 1993) also found that information on career

TABLE 4

NECESSARY INFORMATION FOR NEW SYSTEM

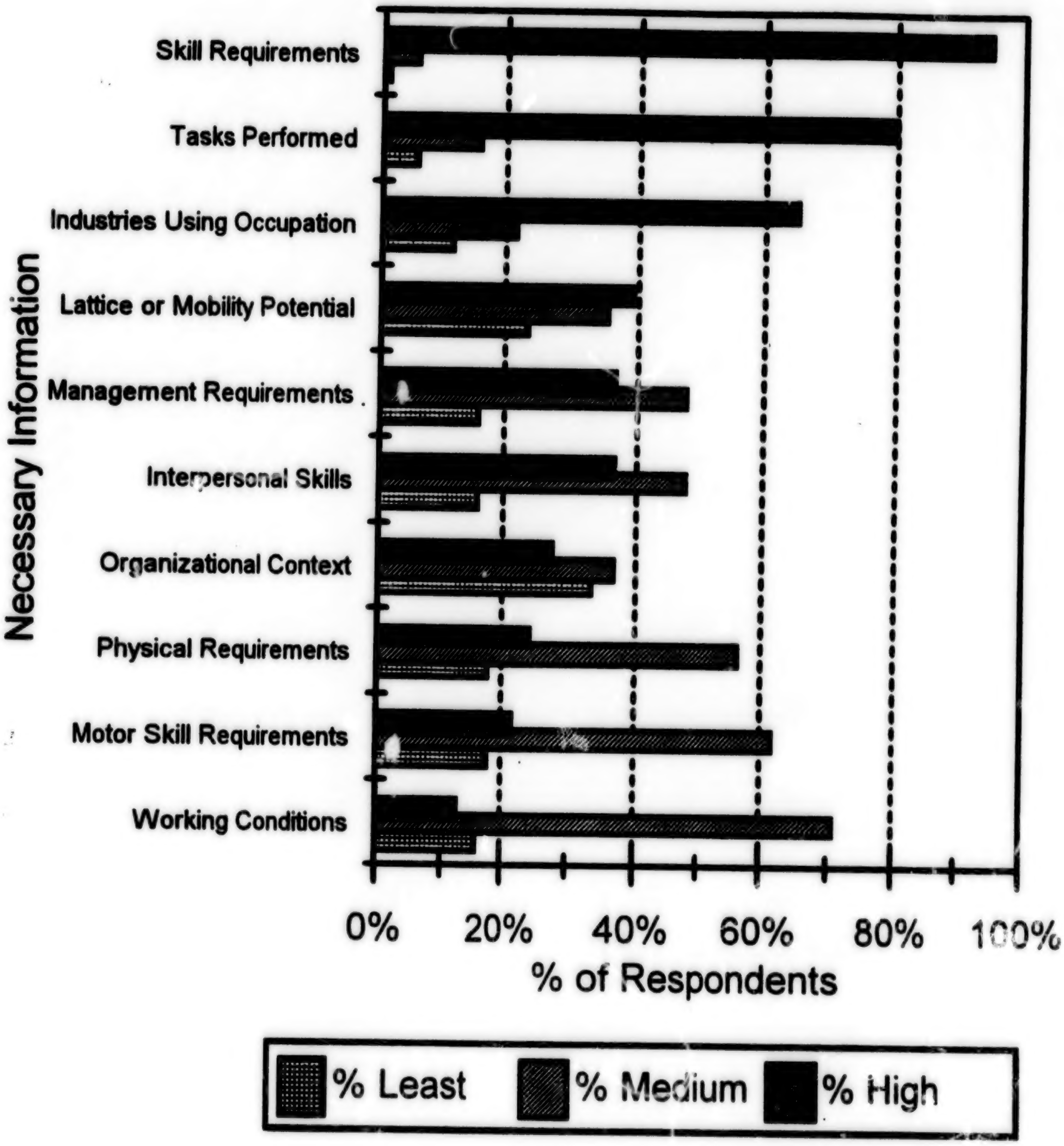
1993 Survey of Labor Market Experts

NECESSARY INFORMATION	*Ratings by Survey Respondents*		
		Number	***Percent***
Skill requirements	most	62	94%
	medium	3	5%
	least	0	0%
Description of tasks performed	most	52	79%
	medium	10	15%
	least	3	5%
Industries using the occupation	most	42	64%
	medium	14	21%
	least	7	11%
Lattice or mobility potential	most	26	39%
	medium	23	35%
	least	15	23%
Management requirements	most	24	36%
	medium	31	47%
	least	10	15%
Interpersonal skills	most	24	36%
	medium	31	47%
	least	10	15%
Organizational context of jobs	most	18	27%
	medium	24	36%
	least	22	33%
Physical requirements	most	16	24%
	medium	37	56%
	least	11	17%
Motor skill requirements	most	14	21%
	medium	40	61%
	least	11	17%
Working conditions	most	8	12%
	medium	46	70%
	least	10	15%
Other	most	9	14%
	medium	0	0%
	least	0	0%
No answer		0	0%

Percentages are calculated based on 66 respondents.

NECESSARY INFORMATION - GRAPH 4

1993 Survey of Labor Market Experts



progression or paths was valued relatively low, with only 33% rating it as "very important." Some informants argued that the changing economy calls for a focus on more generic skills, including greater attention to the supervisory requirements, responsibility, and cognitive abilities of occupations. For example, one informant called for,

> *Information on authority - supervisory responsibility.*

Information about the organizational context of jobs elicited relatively little interest. One-third of respondents gave this low priority, although one person argued cogently for this information element, asking for,

> *Information that would help describe the organizational context of the work (supervisorial relationships, position of job in promotion ladders, firm size, structure, policies etc.) and demographic characteristics (including turnover).*

Relationships Between Societal Objectives and Suggested Improvements

The societal goals regarded as most important by individuals influence what they identify as essential information for an occupational classification system as well as their prescriptions for correcting perceived shortcomings. Consequently, it is important to examine the types of occupational information survey respondents want to have in the context of the societal goals they think should be served by this information.

There were five broad goals that were regarded as very important by half or more of all informants. Three of the goals were directly related to concrete problems of counseling and assisting work-seekers, namely identifying essential skills, helping displaced workers transfer skills, and helping people with barriers to employment obtain skills that will enable them to find jobs. There was substantial overlap among individuals giving a high priority to these goals. These informants included a significant share of people engaged in job placement, counseling, training, hiring, setting wages, and organizing workers. Relatively few of these respondents were engaged in research, and they therefore tended to give slight support for research-related issues.

The other two goals that attracted a great deal of support referred to research activities that provide indirect assistance for worker needs. The goals were providing up-to-date information about labor market changes, and assisting researchers to project future employment. The group of respondents concerned about current information seemed to straddle the employment and research orientations, focussing on a research output that would have direct utility for job placement. The respondents interested in predicting future employment were more sympathetic to the social benefits of all occupational research, such as historical analysis. Two-thirds of these respondents were engaged in research.

It is possible to identify some differences between the job-placement orientation on the one hand and the research orientation on the other (and sub-groupings within each), but more striking is the overall agreement among all respondents. For each of the five groupings defined above by their rating of high priority societal goals, the most common problem reported was out-of-date information, followed by inaccurate job descriptions and excess titles. The fourth problem cited was either inappropriately grouped jobs, or lack of training in understanding and applying DOT codes and traits data.

A similar agreement was evident in judgements about the most important information that an occupational classification system should include. Only small variations were observed among groups. For example, placement-oriented informants tended to give more weight to the need for specific information on interpersonal skills, probably derived from experience with problems in placing work-seekers. Information on interpersonal skills may be especially relevant to the service sector jobs drawing on `emotional labor,' communication and social skills (especially jobs historically assigned to women) that have grown in recent decades.

Some variations between the placement orientation and the research orientation were also evident in the concrete suggestions made to improve the SOC/DOT system, although there was a fair amount of overlap among the five groups. Placement-oriented individuals suggested ways to link the occupational classification system more directly with real job and training opportunities. Suggestions were made to establish a data base on local level demand with wage/benefit summary, training requirements and occupational outlook. One specific proposition for a local data base was to list the telephone numbers and main office addresses for community college districts, adult schools, and other job training sites for training in specific skills. Another noted that we need to address confidentiality issues, and provide employer names and addresses, and what occupations they use, to the public. In his words,

> *We must start providing more than "symbolic" information.*

The comments elicited from research-oriented individuals tended to call for greater links between different data bases and sources of information. Suggestions were made for more use of the DOT by government agencies collecting labor market information, for consideration of the SCANS initiative, and for a fully integrated classification system. One recommendation spelled out a method for surveying under-represented sectors to generate a weighted distribution of industries, and produce a distribution of DOT titles within each OES code. The need for more localized demand and wage information was mentioned by several, as was the need to match occupational information with supply information from training programs.

Specific Suggestions

The wealth of expertise on issues of employment and occupational information among the informants generated a number of insights worth mentioning in detail. Some pointed to new kinds of information that could be collected to shed light on current problems. For example, one individual called for information on the key characteristics of workers who retain employment for one year or more. Another noted that we need to link worker characteristics to firm characteristics. He suggested a random sample of workers at the workplace (as done in Japan) rather than at home (as done in the US). Other individuals referred to the opportunities created by information-processing technology.

> *Due to the extensive number of occupations it is essential that the system be computerized.*

Finally, the problems of designing a satisfactory occupational information system elicited some general comments.

> *Our main concern is that the DOT is no longer getting updated frequently enough. We believe that there is a need for a more generalized system like OES or SOC as well as a more detailed system like the DOT. If one system could combine both features, all the better. It would seem that the Data-People-Things designation of the DOT could be incorporated with a hierarchical system like OES using a greater number of digits in the code.*
>
> *Eliminate the SOC and the old DOT, improving on the OES so that there is only one taxonomy of about 2000 job titles. Then, don't alter the codes for ten years.*

Conclusions from Economic Roundtable Survey

A wide net was cast to draw on the insights and opinions of expert individuals in diverse positions with rather different approaches to the potential use of an occupational classification system. The dimensions of their different perspectives on the social goals to be served by the SOC/DOT system have been outlined above. However, the central finding of this survey is that despite some diversity in origin, they share a remarkably strong consensus on the necessary information that an occupational classification system should contain, and the major problems currently experienced by users. There appears to be broad user support for changes that transform the SOC to become a classification system:

> that can help unemployed workers find new jobs that will utilize their skills as well as provide current labor market information;
>
> in which the most important classification variables are skill measurements;
>
> that provides information about tasks performed in occupations and industries that use each occupation; and

in which information is up-to-date and accurate.

The primary use envisioned for the future system by users is to provide information useful to workers in their search for employment. By improving the quality and accessibility of information available to workers, and to those such as counselors who assist in matching workers with jobs, a broader social interest is enhanced. The most important kind of occupational information for supporting this end concerns skill transferability. Users place high priority on an accurate, up-to-date system with specific information that will offer workers:

1. A common language for enumerating the skills they possess.

2. An effective system for identifying jobs which require their combination of skills.

Meeting User Needs Through the Future SOC

The SOC was developed as a top-down system. A conceptual structure was developed, occupations were defined and described, and DOT titles were then grouped together on the basis of those definitions. Yet in many ways the SOC was unable to establish a well-supported independent internal structure. A cursory examination of the occupational categories suggests several cases in which the delineation of unit groups appears to have been dictated by the range of existing DOT titles, rather than by an attempt to impose consistency.

One of the major problems with the SOC occupational definition derives from its construction from DOT titles. Since there are not adequate empirical data on the relative share within a SOC occupation of each component DOT title, there is no reliable way of characterizing the SOC in terms of DOT variables where the scores on variables differ among the component titles. This makes it particularly difficult to link labor market information (usually collected with SOC-equivalents) to job characteristics identified for the DOT. This is especially true with respect to the measures of skill.

Skill as the Basis for Occupational Definition and Classification

The central focus of the SOC is the aggregation of occupations into larger clusters or job families, consistent with its design as a comprehensive top-down descriptive classification system. Any aggregation is based on principles of clustering using given variables.

Much of the current discussion about revising the SOC revolves around the usefulness of placing a measure of skill or substantive complexity at the center of occupational definition and classification. In other words, skill would become the prime `sorting variable' for occupations, at least to distinguish among the initial broad categories of jobs. The impetus for this derives from increased interest in issues of worker re-employment to deal with economic dislocation, and moves to develop more relevant educational curricula.

What implications does the priority users place on accurate, up-to-date skills and labor market information that helps workers find new jobs have for issues of system structure, information content, and application?

To meet these user priorities, the future SOC basic occupational unit should be defined by specific skill variables (scales for measuring specific skill attributes) rather than only in terms of its component DOT titles. A SOC unit group should be defined in terms of the common skill characteristics shared by the component occupations, expressed in both verbal descriptions and scores on measurement scales for key skill descriptors.

Fully Integrated, "Real Time" Information

The area in which user responses are least helpful is envisioning the architecture and capabilities of a system that is many steps beyond that with which they are already familiar. The potential for a new system to integrate multiple sources of data will have information outcomes and applications that have not been seen before and can transform the role of occupational information in serving workers. The possibilities for a classification system that fully integrates DOT, OES, Census, and public employment service data are not recognized by a majority of respondents only 26% gave high priority to integrating occupational and social information in the Economic Roundtable survey. Issues of system architecture such as data integration and real-time information that are far removed from the actual experience of current users and difficult to visualize appear to be an area in which the needs of Indirect Users should take precedence over priorities expressed by Direct Users.

A potential strength of the new SOC is its capacity to fully integrate the wealth of occupational information collected by job analysis with the employment statistics and demographic information collected through OES surveys and the Census. An uncomplicated and widely accepted occupational classification which simplifies and aids the connection among these data sources will have a synergistic effect in increasing the power of the information.

With the SOC as the primary occupational classification system in an overall system in which there is no need for crosswalks, occupational information and labor market information can be collected for the same occupational classification units. This will create a powerful new information resource in which information about workers and industries will be linked directly together through the same occupation groups.

It should be possible to obtain "real time" information about what happens to workers with specific skill attributes who are in specific occupations by integrating wage and claims data showing earnings and employment histories of workers with job service occupation coded data showing the previous and new placement occupations of individuals receiving public employment services. Policy-relevant issues about which this will provide information include the following:

- career transition paths
- outcomes for displaced workers
- job stability in specific occupations
- earnings patterns in specific occupations
- occupational distribution of unemployed workers and ratios of employed to unemployed workers in each occupation

By integrating this information with Census data it will be possible to obtain insights into:

- demographic characteristics of workers in specific occupations
- skill attributes of workers in specific geographic areas
- worker attributes associated with obtaining employment in specific occupations
- worker attributes associated with retaining employment in specific occupations
- worker attributes associated with upward mobility

Similarly, by integrating occupational matrices, jobs listed with the public employment service and quarterly employer reports showing employment by industry, it will be possible to provide information about:

- occupations in which job creation is occurring
- critical skill shortages which constrain industry growth
- changes in occupational composition of specific industries
- interrelationships between changes in occupational structure and changes in industry employment levels and skill requirements

A new SOC that supports this data integration will also have built-in capabilities for improving the integrity and labor market-relevance of its own classification structure by identifying cross-occupational linkages that indicate transferability of skills or experience. The 1980 critical review of the DOT (National Research Council, 1980, pp. 201, 207) noted:

> *Because the transferability of skills is generally regarded as the most appropriate criterion for assessing the similarity of occupations with a view to matching jobs and workers . . . . a mobility approach may provide . . . an empirical criterion for judging the similarity of occupations and the substitutability of labor . . . . In the mobility approach, occupations are grouped solely because of high degrees of movement between them . . . . [providing] a basis for constructing classifications.*

The ability to offer accurate, timely and specific insight into workforce skills will transform labor market information from something that is now theoretical and generalized to into something that is strategically valuable and demonstrably improves the lives of workers. Even though these possibilities are far beyond the experience of current Direct Users, the design of the new SOC should ensure that these possibilities can be realized because of the important public benefits they will offer in terms of improved workforce opportunities and productivity.

Recommendations

A primary test of the usefulness of occupational information is its power to provide accurate, grounded insights that actually improve labor market outcomes for workers. Important public interests rest on the capacity of the future SOC to provide occupational information that is responsive to the needs of both direct and Indirect Users. The preliminary assessment of Direct and Indirect Users presented in this paper suggests that in order for the future SOC to respond to their real wants and it should be designed to:

1. Serve the needs not only of Direct Users, but also Indirect Users, who are the intended beneficiaries of the public investment in producing occupational information.

2. Provide information that is tangibly helpful for achieving the highest priority societal interest for occupational information identified by all user groups, namely helping workers who need jobs become employed.

3. Use a classification system based on worker skills.

4. Provide current, accurate information, including descriptions of essential skills and competencies, tasks performed, and industries in which occupations are found.

5. Support projections of future employment.

6. Fully integrate all publicly produced employment information about workers and occupations, including occupational classification data from the DOT, industry employment data from the OES, worker demographic information from the Census, and earnings and employment data from the public employment services.

Postscript

This report was presented on April 11, 1995, at the Seminar on Research Findings held by the Standard Occupational Classification Revision Policy Committee and the Federal Consultation Group. At that seminar, authors presenting papers were asked to give their assessment of whether the Policy Committee would be moving in the right direction if it designed the future

SOC based on six readily measurable occupational characteristics, namely:

1. licensure and certification
2. work experience
3. generalized work activities
4. tasks performed (to the extent measurable)
5. formal education
6. formal training

Based on the information available to the authors of this report, it is our assessment that this would not be a move in the right direction. Occupational classifications created based on this limited range of measurements would offer much less information than the current DOT and would not be responsive to the highest societal priority identified by users, namely providing information which will improve the ability of unemployed workers to transfer their skills to new occupations. Important information about skills that would be missing includes:

7. required physical capabilities and motor skills (these are skill equivalents for low-skilled occupations)
8. occupation-specific skills and knowledge
9. essential competencies required to be job-ready and employer-acceptable
10. cross-functional (or generic) skills

In order to be responsive to user needs for skills information, the design, or super-structure, of the new SOC should give the last three information elements (items 8 through 10 above) more weight than the first four information elements (items 1 through 4 above). If the new SOC super-structure is designed without having access to these crucial new categories of skill information it may well be that it will not be possible to incorporate this information at a latter date. This is because the new occupational classifications must be built by creating groupings of jobs with homogeneous characteristics.

If occupational classifications are created for the new SOC using old, rudimentary measurement scales, there is no assurance that workers within them will be homogeneous in terms of their ratings on new scales measuring more useful skill characteristics that are introduced at a later date. If workers within an occupation are not homogeneous in terms of their ratings on yet-to-be-introduced skill measurement scales those skill descriptors become unusable. An example of this would be if workers in an occupation were found to be equally divided in terms of those who have SVP ratings of 4, 5, and 6, or GED ratings of 2,3, and 4. This would make SVP or GED ratings inapplicable to that occupation because it would be impossible to apply a valid rating to workers in the occupational group. The solution to this problem is to have data from the new skill measurement scales available at the time that occupational groupings are being created, and using that data to assure that workers who are grouped together into occupations have similar ratings on the measurement scales for key skill factors.

The six skill measurements offered for assessment at the April 11 seminar have the advantage of being readily adaptable to data collection through household or employer surveys. This is an important consideration for the future SOC because it should provide a single classification system that will be used when collecting data for the Census, OES, and DOT, the first two of which collect data through surveys. However, the need for skill measurement factors that can be used to classify occupational data collected through surveys does not need to limit the overall data content of the new SOC. More extensive and difficult-to-collect data related to skill factors can be obtained through supplemental interviews, tests, and job analyses with small samples of workers. In this way the new SOC can be an integrating frame of reference for information about the same set of occupations that is obtained through multiple data collection programs.

For the new SOC to be responsive to the needs of users, and through them needs of the nation's working men and women, it must incorporate a wide range of skills-related information including indicators of cognitive requirements, complexity, responsibility, training requirements, and specific hiring criteria. It is particularly important that the SOC basic occupational units contain information elements that help workers seeking re-employment transfer occupation-specific skills from their old jobs to new jobs.

USER INFORMATION

For National Occupational Classification System

Your Name:________________________ Your Position:____________________

Institution:________________________ Telephone No. (___)________________

Please use an extra sheet of paper if you need more space for your answers.

1. Please check items which identify your chief duties:
   - _____ Job placement
   - _____ Hiring
   - _____ Setting wages
   - _____ Training
   - _____ Counseling
   - _____ Organizing workers
   - _____ Human resources activities
   - _____ Research (please specify) ______________________________
   - _____ Other (please specify) ______________________________

2. Have you heard of the Dictionary of Occupational Titles (DOT)? ___ Yes ___ No

   Standard Occupational Classification (SOC)? ___ Yes ___ No

   Occupational Employment Statistics (OES)? ___ Yes ___ No

3. What system(s) for classifying occupations do you use in your work?

   ___ In-house system ___ DOT ___ Other __________________ ___ None

   What problems do you experience in using occupational classification system(s)?
   - _____ Don't understand the system
   - _____ Have not had training in the DOT numbering system or worker traits data
   - _____ Does not accurately describe the jobs of workers
   - _____ Information is out of date
   - _____ Too many job definitions
   - _____ Jobs are not grouped together appropriately
   - _____ Does not list some jobs (please give an example) ____________________
   - _____ Important information is missing (please specify)____________________

     ____
   - _____ Other____

4. What kind of information about worker characteristics, job definitions, worker/employer demands, or skill requirements would help you in your work?

5. What do you think are the highest priority needs that should be served by a new national standardized occupational information system?

	High	Med.	Low
Help people with barriers to employment get jobs?	___	___	___
Help displaced workers transfer their skills to new jobs?	___	___	___
Identify career advancement opportunities for workers?	___	___	___
Identify essential skills or competencies that workers need to have to be job-ready and employer-acceptable?	___	___	___
Help workers make successful job and career choices?	___	___	___
Provide up-to-date information about labor market changes?	___	___	___
Assist researchers to:			
project future employment?	___	___	___
integrate occupational and social information?	___	___	___
do historical analysis?	___	___	___
make comparisons with other countries?	___	___	___
investigate work-related health problems?	___	___	___
Other________________________	___	___	___

6. What kind of information do you think it is most important to have about jobs?

	Most	Med.	Least
Skill requirements (education, training and abilities)?	___	___	___
Description of tasks performed?	___	___	___
Motor skill requirements e.g. dexterity, coordination?	___	___	___
Physical requirements e.g. lifting and moving?	___	___	___
Management requirements e.g. planning, communicating?	___	___	___
Interpersonal skills e.g. tact, sensitivity?	___	___	___
Organizational context of jobs e.g. firm size, unions?	___	___	___
"Lattice" or mobility potential for the job?	___	___	___
Working conditions e.g. heat or job hazards?	___	___	___
Industries using the occupation	___	___	___
Other________________________	___	___	___

7. Please provide any comments or suggestions.

8. Please list the names, organization affiliations, addresses, and telephone numbers of other individuals who you think should be contacted as part of this survey.

THANK YOU FOR YOUR COOPERATION!

For further information, please telephone (213) 892-8104. Please return survey to: Economic Roundtable, 315 W. 9th Street, Suite 310, Los Angeles, CA 90015. FAX: (213) 892-8105.

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OBSERVATIONS REGARDING A REVISED STANDARD OCCUPATIONAL CLASSIFICATION SYSTEM USING A SKILLS-BASED CONCEPT

to
Advise the
SOC ADVISORY PANEL

for

DTI GOVERNMENT AND COMMERCIAL SERVICES GROUP
AND U.S. DEPARTMENT OF LABOR

Ronald D. McCage, Ed.D., Executive Director
Chris M. Olson, Ph.D., Director of Product Development
Vocational-Technical Education Consortium of States
Commission on Occupational Education Institutions
Southern Association of Colleges and Schools
1866 Southern Lane
Decatur, Georgia 30033-4097
(404) 679-4544

June 1995

The authors accept all responsibility for the accuracy of the contents of the paper, and for all opinions that are expressed. There should be no presumption that these views are shared by anyone affiliated with the sponsoring agency, the Department of Labor.

OBSERVATIONS REGARDING A REVISED STANDARD OCCUPATIONAL CLASSIFICATION SYSTEM USING A SKILLS BASED CONCEPT

By

Ronald D. McCage, Ed.D.
Chris M. Olson, Ph.D.

EXECUTIVE SUMMARY

Background

The United States Department of Labor (DOL) is well into the redesign of the Dictionary of Occupational Titles (DOT) using a database content model. Concurrently, the Office of Management and Budget (OMB) is working with the Bureau of Labor Statistics (BLS) to revise the Standard Occupational Classification System (SOC). There are at least two schools of thought concerning what the system should look like: one based on skills; the other on economic considerations. The purpose of this paper is to define what is needed to build such a system using a skills-based concept. This will be achieved by conducting a thorough analysis of all existing classification systems as well as the new DOT/O*NET content model so that any recommendations made regarding the revisions of the SOC system would be in concert with the evolving DOT Content Model as it moves to the O*NET configuration. The authors also borrowed heavily from the McCage IEL/DOL article, "Observations Regarding the Development of Occupational/Skills Clusters" written earlier to advise the National Skill Standards Board process.

The first task the designers of the new SOC have to face is determining the framework for separating out or classifying the various industries, occupations, clusters, and jobs that exist in the workplace. They will have to decide whether they will need to invent a totally new structure or build on what already exists. In our opinion, there is only one answer, and that is to build on what already exists. While a new structure would be nice, the cost in developing such a system would be prohibitive, not to mention the inconvenience to those who already use the current systems. More importantly, it is our opinion that the existing systems are reasonably sound. The basic problem is that there are too many different systems which have to be interpreted through crosswalks.

Consequently, we recommend that the new SOC become what it was supposed to be from day one: the crosswalk, or better yet, the single system that replaces all other major occupational classification systems currently in place. To be more accurate, what we are recommending is that SOC become the system or framework for consolidating the OES survey-based matrix, OES survey occupational codes and titles, and the current census code. We think that there are good elements in each of these that could be condensed around the OES matrix titles to build one system with three to four levels of specification for some 600 - 700 occupational clusters organized under 12 to 14 major occupational families. We believe that the Prototype Skills-Based Job Family Matrix is an excellent place to start for building an hierarchial framework for the SOC and DOT/O*NET. We have recommended the Prototype Matrix because it has fourteen logically defined occupational families under which most occupations could be clustered with minimum duplication. An analysis done by McCage for an earlier skill standards board paper came up with fourteen similar titles by simply using deductive reasoning to collapse and slightly alter the major category families in the 1990 Classification of Instructional Programs. The classification systems used by the U.S. Military and the federal government for personnel management should be maintained since they serve highly specialized audiences.

Conclusion and Recommendations

Rather than address the Twelve Principles of Classification for the 1980 SOC, the authors have used the questions at the beginning of their paper to serve as a framework for presenting their conclusions which are based on our supply-side experience in the vocational-technical education community as well as having worked with business and industry to analyze work. Our general conclusions are as follows:

1. An occupational analysis protocol must be developed that allows for the continual flow of new and fresh information into the new DOT/O*NET and subsequently into the revision and updating process for the new SOC. If a consistent protocol was developed, such as the one currently being used in the Indiana Proficiency Panel Initiative, an information exchange could be arranged to permit the database to be fed from a variety of sources outside of the typical governmental agency units charged with collecting and summarizing the data. Such a protocol would have to follow precepts of the Total Quality Management concept in order for the exchanged data to have validity and reliability.

2. A common language should be adopted for the collection of data that is to be used for defining the occupational titles to be included in the database. The authors recommend a combination of duty/task statements or generalizable work activity statements coupled with descriptions of the skills needed in the occupation which could be organized using a framework such as SCANS. This would be supplemented with data sets drawn from the APDOT process which would be applied equally to those performing analysis to identify jobs on the demand side and to those developing training on the supply side.

   The authors would like to cite from the Drayse, et. al., article on the "Future Use of the SOC" in the Proceedings of the International Classification Conference because it expresses very well our feelings about the issue of using an economic or skills-based model.

   > A primary test of the usefulness of occupational information is its power to provide a plausible, grounded account of the actual experience of workers. Just as a job should connect an individual's activities with a larger group of workers and their activities, and that in turn with the output of a product or service that is valued by a changing society, a useful description of that job should reflect significant characteristics of the worker, the activity, linked activities of other workers, and processes of change. Since the labor market is not in equilibrium, descriptions of constant and established factors offer good but only partial insight; in effect, a snapshot in time. The dynamic relationships among occupations, and between occupations and changes in demographics, production processes and markets, make it necessary to continuously incorporate fresh information into occupational classification systems (p.48).

3. A consistent occupational classification structure should be developed to maintain the integrity of the customer/supplier relationship between the various agencies that collect, report, and use labor market data. This structure can be modeled after existing structures such as the CIP but should be hierarchical as follows:

Numbering	Name of Occupational Field	Example
00.	Family/Industry	Creative Arts
00.00	Cluster/Programs	Architecture Cluster
00.0000	Specialties/Clusters/Skills	Landscape Architecture
00.000000	Job Titles (DOT Level)	Landscape Architect

4. The authors feel that the existing classification systems can make substantial contributions to this initiative to revise the SOC. People who use and report labor market information from both the supply and demand sides have gained valuable experience and insights into what the future system should include and how it should be structured. It would be folly to ignore this and begin to develop a revised system from scratch.

5. There should be a direct relationship between the occupational clusters, selected occupational analysis system(s), and the data collection system(s) used that will redefine the new Database of Occupational Titles, Standard Occupational Classification System, and the National Skill Standards Board. We contend that a system can be designed using a hierarchy from general to specific perhaps with four levels (but not necessarily limited to four levels) which will account for current and future occupational structures and will provide satisfactory information for customers of the data. We feel that the Prototype Skills-Based Job Family Matrix is such a framework.

6. It is recommended that the NOICC Units of Analysis be considered as a scheme for identifying occupational clusters as they relate to occupational titles. The authors have been provided the most current work being done on the Units of Analysis by the NOICC staff and are very impressed with it. It is envisioned that the Units of Analysis as used in the state Career Information Delivery Systems (CIDS) would provide a valuable tool permitting multi-state surveys of the activities of incumbent workers in various occupations. The recommendation is that such surveys be conducted in a manner similar to the Indiana protocol. By using the Units of Analysis, planning can be done to identify areas for analysis and enhance the placement opportunities of program completers or graduates.

7. The DOT/O*NET and SOC should be used for statistical and planning purposes for the education and training environment as well as for all other traditional uses. If the hierarchy suggested previously can be implemented, the SOC will be a more general category of related DOTs, since DOT data can be aggregated to the SOC level. If this concept was adopted, a collecting and reporting data process could be developed whereby vocational-technical education and other training providers could provide the information required to develop relevant programs for the current workforce.

   The following data sets should be present in a O*NET/SOC information base for use by vocational-technical education and school-to-work program planners, curriculum developers, and counselors:

Demand Data
(Employment)
- Historical employment (currently 1984 levels)
- Current employment (1995)
- Average annual job openings (growth + replacement)
- Hourly wages
- Some form of a SVP

Supply Data
(Enrollments by Occupational Cluster)
- Secondary
- 2 Year Postsecondary
- College/University
- Adult Secondary
- Proprietary
- Apprenticeship
- Military
- Other

8. The authors realize that the SVP doesn't have much stock with the current DOT/O*NET and SOC developers, however, we believe the concept behind the SVP is very important to the education and training community since it does provide very important clues as to the structure of career ladders. Training time is probably a reasonably accurate descriptor since it considers both school based and work based preparation. The SVP concept should be modified around the following five levels since they reasonably represent the ways people become prepared for the workplace.

Level 5	CEO, Management Administration, Advanced Degree
Level 4	Supervisor, Basic Degree, Advanced Professional Certificate
Level 3	Master Technician/Journeyman Level, Postsecondary Degree or Certificate of Mastery
Level 2	Specialist Level, Postsecondary Certificate of Mastery, Secondary Certificate of Mastery, On-the-job Training
Level 1	Trainee Exit Level, Position Entry Level, Secondary Diploma or Certificate of Mastery

9. A properly designed system can be used as a framework for certifying workers in their various industry or occupational specialties by using national or state level skill standards and certifying processes. In Indiana, the Certificate of Technical Achievement will serve this purpose and look similar to a portfolio. In other situations individuals will sit for an exam or actually perform relevant work activities to demonstrate competence.

10. The new DOT/O*NET/SOC must use a common language for building occupational clusters as well as for identifying common or transportable skills that cut across industry families/occupational clusters/specific occupations as well as geographic boundaries. This must take the form of a well designed taxonomy of work activities and skills which doesn't currently exist.

    The authors have experience in setting up and implementing a model for identifying the literacy skills found in the workplace. They used the GED definitions as found in the DOT as well as other sources for developing descriptors for classifying literacy skills. These skills were placed into a matrix and were coded to jobs and an assessment of people. The discrepancy between the people assessment and the job assessment was used to identify training needs.

    The authors' experience with the GED indicated that a consistent set of skills could be used in a variety of work environments and on a variety of jobs. For example, V-TECS has the Basic/Essential Skills Taxonomy developed by Lester M. Snyder, Jr. at Arizona State University. This or a similar "skills" taxonomy could be used to craft a consistent set of skills that could be applied across occupational levels. Once a skill has been identified and verified as relevant to the workplace and is not redundant to another skill in the database, it could be added. In this way, at the skill level, occupations could be described in a common language. This does not preclude the possibility that a contextual qualifier couldn't be added to the basic skill. In fact, the qualifier may be necessary in some levels to make distinctions in and among occupations given the trend toward over generalization.

PURPOSE AND BACKGROUND

The United States Department of Labor (DOL) is well into the redesign of the Dictionary of Occupational Titles (DOT) using a database content model called O*NET. Concurrently, the Office of Management and Budget (OMB) is working with the Bureau of Labor Statistics (BLS) to revise the Standard Occupational Classification System (SOC). Everyone involved in this process has expressed a desire to move more toward a single occupational classification system using a SOC/DOT framework. At a minimum, all parties involved want to make these two systems as compatible and as interactive as possible so that much of the existing duplication can be eliminated from the various occupational classification systems currently operating in the United States.

Given the current dialogue regarding the numerous changes that are taking place in the workplace, many policy makers believe that our occupational classification systems should be moved away from the traditional concepts of classifying work based on tasks performed to a system based on skills clustering or economic considerations. This paper will strive to define what is needed to build such a system using a skills-based concept. This has been achieved by conducting a thorough analysis of all existing classification systems as well as the new DOT Content Model so that any recommendations made regarding the revisions of the SOC system will be in concert with the Database Content Model of the evolving DOT. The authors also borrowed heavily from the McCage IEL/DOL article, "Observations Regarding the Development of Occupational/Skills Clusters" written earlier to advise the National Skill Standards Board process.

A. STRUCTURE

The first step taken in writing this paper was to carefully review the background papers provided by Emily Parry of Defense Technology International (DTI) and Donna Dye of the Department of Labor so as to better grasp the primary issues and questions that should be addressed in this paper. The primary documents reviewed include the Proceedings of the International Occupational Classification Conference that was held in Washington, DC, on June 23-24, 1993, as well as the fifteen papers recently prepared to advise the National Skill Standards Board (NSSB) which dealt with a number of the same issues regarding skills identification and clustering that are being faced by those redesigning the SOC and DOT/O*NET. Obviously, the revision of the DOT and SOC should be coordinated with the implementation of the National Skill Standards Board since Title V of the Goals 2000 legislation calls for a framework of some 10-20 occupational families as a guiding principle for the grouping of occupational clusters. As a consequence, the following questions were selected as being the most critical to this discussion.

1. What do the existing classification systems have to offer this endeavor?

2. What should be the relationship between the occupational clusters and the occupational analysis system(s) and data collection system(s) that will redefine the new Dictionary of Occupational Titles, Standard Occupational Classification System, and the National Skill Standards Board?

3. How many occupational clusters will ensure coverage of the world of work?

4. Should the SOC occupational classifications be developed using a supply/demand (economic) base or a skills/work activity base?

B. USE

The authors pose several questions concerning the possible uses of a skills-based SOC which this paper addresses.

1. How does the vocational technical education and training community (supply side) use this type of information?

2. How can the DOT/O*NET and SOC be used for statistical and planning purposes for the education and training environment as well as for other users?

3. How can a properly designed system be used as a framework for certifying workers in their various industry or occupational specialties?

4. How can the concept of a skills taxonomy be used as a common language for building occupational clusters as well as for identifying common or transportable skills that cut across industry families/occupational clusters/specific occupations as well as geographic boundaries?

C. INDIANA SCENARIO

When we were asked to write this paper, we were asked to illustrate how the vocational/technical education and training community makes use of the various classification systems in designing and delivering programs. This is quite significant since most of the reading we did regarding the SOC was from the perspective of the demand side. Our discussion begins with the Indiana Scenario which illustrates how labor market information is used to drive program and curricular decisions.

In 1992, a significant event occurred in Indiana with the passage of P.L. 19-1992 which created the Indiana Workforce Proficiency Panel. The Panel was named by Governor Evan Bayh and includes representatives of education, organized labor, business and industry.

> *The mission of the Workforce Proficiency Panel is to work with people from business, labor, and education to identify a common set of essential and technical skills required to be effective in major occupational areas. These skills will be based on a portable certification system allowing secondary, postsecondary, and adult learners to demonstrate what they know and can do.* Taken from Annual Report: Indiana Workforce Proficiency Panel, July 1994, p. iii.

A Customer Driven Approach:

The Indiana Workforce Proficiency Panel wanted employers to identify what their employees needed to know and be able to do in order to perform high quality, competitive work. The Panel asked employers to identify and validate essential skills and technical proficiencies required for Indiana's major occupations. The Panel designed a process to produce knowledge and skill standards which are industry-based, useful for making hiring and promotional decisions and that are valid statewide. The Panel considers the "Customer" of the proficiencies to be the workplace and developed a Handbook to provide a protocol to ensure that a consistent process was in place for assessing and certifying skills for:

- students at the secondary and post-secondary level,
- employers who want to provide necessary training and provide employee compensation for what their employees know and are able to do, and
- adults seeking employment, desiring to change jobs, or wishing to create an inventory record or portfolio of their work experiences.

Certificates of Technical Achievement:

Certificates of Technical Achievement will be used to describe and certify a person's proficiencies and will function as "open transcripts." They will provide a record of what a person knows and is able to do, not where and how knowledge and skills are learned. Certificates will be upgraded as participants complete additional secondary, postsecondary and/or employer sponsored education and training. Agencies and/or institutions can be authorized by the Workforce Proficiency Panel to develop and conduct the assessments according to the standard protocol. The standard protocol will ensure consistency among all assessments and ensure statewide validity and portability of the Certificates.

Skill Portability:

Agreements between and among secondary and postsecondary education and training providers to ensure geographic portability are being developed. Institutions participating in this process must provide evidence of commitment by:

- awarding advanced standing/dual credit,
- decreasing time/credits required to complete a program of study,
- reducing costs for program completion, and/or
- providing other advantages to students.

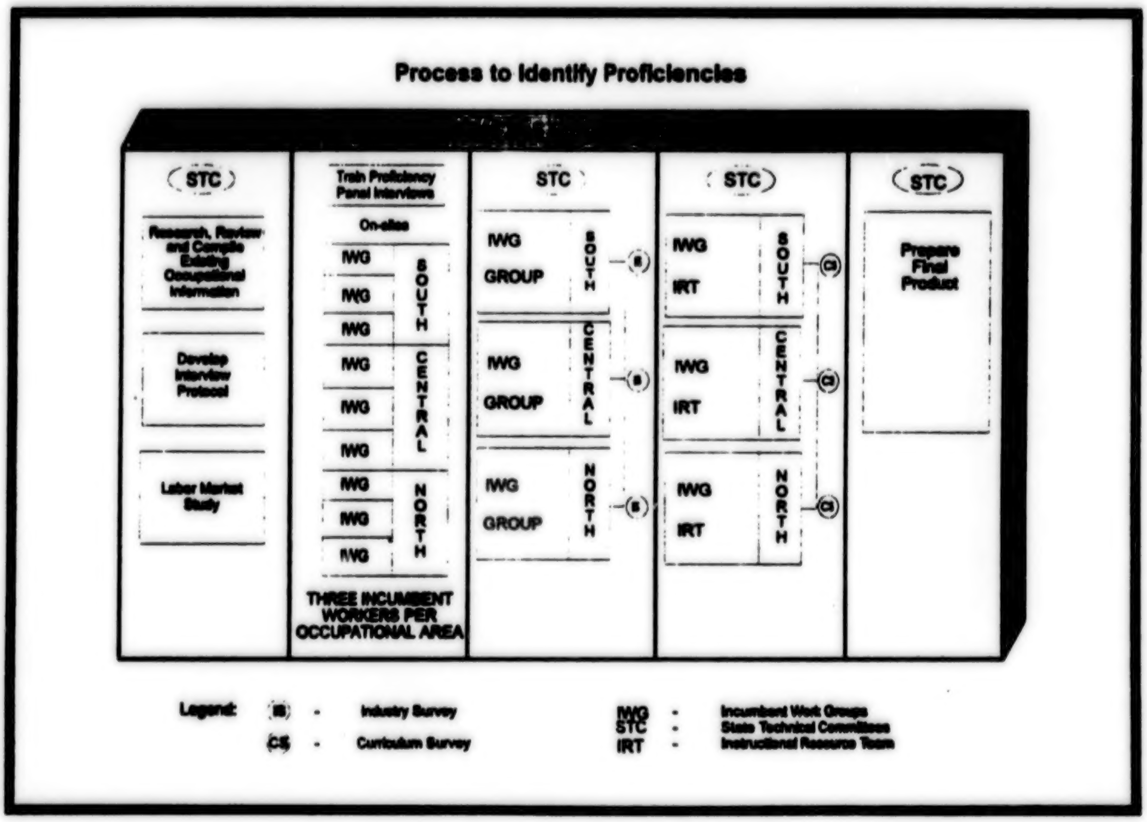
These agreements add value to the Certificates of Technical Achievement, and will foster movement toward competency-based admissions at state-sponsored postsecondary institutions. This process encourages School-to-Work Transition or Youth Apprenticeship Programs where education and business and industry are working together to provide an articulated program designed to develop a world-class workforce. In addition, business and industry participation in this process, perhaps with the assistance of the Indiana Workforce Development Centers, allows current workers to be assessed with Certificates being issued to assist in hiring and promotional decisions. The Proficiencies provide a continuum of essential skills and technical proficiencies that provide for recognition of a person's "real" skills whether they are earned in the secondary, postsecondary, or workplace environment and allows a person to continually improve and expand their repertoire of skills (open transcript). The protocols have been designed to be consistent with the primary elements of the many Quality Models now being widely implemented in business and industry and education. Because Total Quality Management is very much a part of the Indiana Essential Skills and Technical Proficiency Program, the protocols identify a process that can be monitored, analyzed, and continually improved.

The Process to Develop the Proficiencies:

The process to develop the proficiencies follows a protocol that has been formally approved by the Workforce Proficiency Panel. The resulting product of the process, the Proficiency Guide, includes a report of the duties and tasks performed in the occupation, the tools and equipment that are used, and the context in which work is performed using SCANS as an architectural framework. The developmental components are:

- Review of Labor Market Supply and Demand Information
- Establishment of State Technical Committees (STC)
- Conduct of On-site Visits to Business and Industry
- Conduct of Statewide Surveys to Validate Tasks
- Identify Proficiencies Using Incumbent Worker Groups (IWG)
- Review/Edit by Incumbent Worker Groups/Instructional Review Teams (IWG/IRT)
- Prepare Final Proficiency Guides

FIGURE 1
Process to Identify Proficiencies


Process to Identify Proficiencies
STC
Research, Review and Compile Existing Occupational Information
Develop Interview Protocol
Labor Market Study
Train Proficiency Panel Interviews
On-sites
IWG
IWG
IWG
SOUTH
IWG
IWG
IWG
CENTRAL
IWG
IWG
IWG
NORTH
THREE INCUMBENT WORKERS PER OCCUPATIONAL AREA
STC
IWG GROUP
SOUTH
IWG GROUP
CENTRAL
IWG GROUP
NORTH
IS
STC
IWG IRT
SOUTH
IWG IRT
CENTRAL
IWG IRT
NORTH
CS
STC
Prepare Final Product
Legend:
IS - Industry Survey
CS - Curriculum Survey
IWG - Incumbent Work Groups
STC - State Technical Committees
IRT - Instructional Resource Team

Review of Labor Market Supply and Demand Information:

The MICRO-OIS System sponsored by INDOICC (Indiana Occupational Information Coordinating Committee) was used to identify high demand, low supply occupations. There were four components to this process:

- Examine labor market supply and demand information on the MICRO-OIS.
- Identify high demand occupations based on employment data, projections, percent change, industry growth, etc.
- Review supply information from secondary and postsecondary schools, apprenticeship programs, proprietary schools, the military, and supply in the employment and training system.
- Determine the priority of major occupational areas in which to develop Proficiencies.

The MICRO-OIS that provided the Labor Market Information basically uses the NOICC Units of Analysis that matches occupational demand information collected through the OES process with supply information reported through the CIP classification structure. The process is very helpful to the education and training community but it is less than precise due to the incompatibility of the OES and CIP classification systems it is based on. An examination of a MICRO-OIS report does not always provide good matches, consequently, the user must interpolate the data and make generalizations about various relationships between jobs as they are performed versus programs as they are delivered.

The authors propose that the new SOC be designed in such a way that data can be collected and reported that will provide a more precise match with supply data to ensure a more meaningful response by training providers and placement agencies to the employment and training needs of business and industry. Statistics related to persons employed in occupational/skills clusters are needed as a basis for determining which clusters should be addressed for evaluating training needs in terms of growth and replacement. Such information cannot be determined from individual employers. Occupational families or clusters lend themselves much more readily to the gathering of labor market data which are critical to this effort. One of the major problems that local program providers have had for years is that the structure for collecting labor market data doesn't match the structure for organizing occupational clusters and delivering programs as demonstrated in the Indiana experience. This is why the current NOICC Units of Analysis and proposed refinements, such as the Super Units of Analysis being developed by NOICC have extremely high value for the education and training community.

Establishment of State Technical Committees (STC):

The process in Indiana continues with the formation of State Technical Committees. These committees are composed of management level personnel from select companies in Indiana which are geographically distributed, range in size, include those that are minority owned, and represent all aspects of the major occupational area. For example, the STC for Electronics included representatives of avionics, biomedical equipment repair, automotive repair, consumer repair, computer equipment repair, etc.

To identify companies, the results of the prioritization process are communicated to the Labor Market Information section of the Indiana Department of Workforce Development. They "cross-walk" the OES codes from the MICRO-OIS to employer lists coded by SIC (Standard Industrial Classification). Reports are generated that identify businesses who employ persons in the occupations under consideration.

Employers on this list are ordered by size, location, ownership, etc., and then contacted by staff. They are asked:

- Are they willing to participate on the State Technical Committee?
- Are they willing to host an on-site visit for the Development Team?
- Are they willing to supply incumbent workers to help identify the Proficiencies?

The STC meets three times for a given proficiency area. At the first meeting, committee members are oriented to the process, identify sites for visits of the Development Team, and nominate incumbent workers to write the Proficiencies. At the second meeting, progress is reported to include the work of the incumbent workers. At the third meeting, the committee considers approval of the Proficiencies. Approval is required by the STC from the industry before the Proficiencies can be presented to the Workforce Proficiency Panel for their adoption. This requirement is also a part of the National Skill Standards Board guidelines.

Conduct of On-site Visits to Business and Industry:

A minimum of nine on-site visits are scheduled to help the Proficiency Development Team to understand the context of work in the broad occupational area and to gather information for the development of the Proficiencies. The on-site visits include a tour of the facility and interviews with incumbent workers. If the employer hosting the on-site visit has contributed an incumbent worker for the next phase, that person is interviewed and oriented to the responsibilities of an incumbent worker in the process.

Conduct of Statewide Industry Survey to Validate Tasks:

In order to verify the duties and tasks performed in the occupation, a survey is sent to a random sampling of over 120 businesses and industries statewide that employ persons in the major occupational area. The results of this survey are cited in the final report.

The businesses and industries are identified from the employer lists submitted by the Labor Market Information section of the Indiana Department of Workforce Development. Employers are randomly selected and surveys are mailed. If a suitable response is not received, follow-up calls are made.

Identify Proficiencies Using Incumbent Worker Groups (IWG):

Concurrent with the statewide survey, and after the on-site visits are completed, three regional meetings are scheduled with incumbent workers. At these meetings, each worker identifies from duty and task lists those they perform as a part of their job. Secondly, each worker identifies the tools and equipment they use from a list that is provided. Workers are also encouraged to add duties and tasks and/or tools and equipment that have been missed in the earlier stages or represent emerging technology.

Finally, a facilitator from the development team conducts a structured interview/response process which uses the SCANS architecture to identify the context in which work is performed. In this process, the facilitator discusses how each SCANS Competency was observed during the on-site visits. Then each IWG records how they perform the competency as part of their job. This process is repeated for each of the 20 SCANS competencies.

The results of the three incumbent worker meetings are entered into a computer database template in preparation for the next phase.

Review by Incumbent Worker Groups/Instructional Review Teams (IWG/IRT):

This phase brings the incumbent workers together with an instructor from the occupational area being reviewed. The purpose of this meeting is to incubate confidence on the part of instructional personnel that the Proficiencies represent on-the-job practices as reported by incumbent workers. A second purpose is to ensure that the Proficiencies were not altered in such a way when they were entered into the template to negate their content validity. Finally, the instructor and worker identify behavioral indicators organized around the SCANS Foundation Skills to be used to assess proficiency developed in the classroom laboratory and/or the workplace.

Prior to the IWG/IRT meeting, each instructor is asked to complete a survey which reports the duties and tasks they teach in their programs. The results of this survey are compared with the statewide survey and the incumbent worker survey. This provides a discussion piece to help identify discrepancies between what is reported as performed in the workplace and what is reported as being taught in the education and training environment.

Prepare Final Proficiency Guides:

The Indiana Essential Skills and Technical Proficiencies for the occupational area result from this process. The skills data collected from the STCs, the on-site visits, the statewide surveys, IWG input and IWG/IRT review is entered into the V-TECS DIRECT Database. The results of the statewide survey, incumbent worker survey, and instructional survey of worker skills are reported to provide users the capability to compare the various survey results. For example, employers might find that there are tasks being performed statewide that could improve their company's competitive performance. The employer might also survey their existing workforce and compare the results with the statewide survey to identify training needs. Curriculum developers can compare the instructor survey to the statewide results and identify areas where increased emphasis is required.

In addition to the duties and tasks, each Proficiency Guide contains the IWG inputs using the SCANS architecture. This information is entered as text data and provides individual "snapshots" of various workers in the broad occupational cluster as to how they perform SCANS skills as part of their employment. With this information in V-TECS DIRECT, keyword searches can be conducted which allows users to quickly locate information that has particular value to their application. Figure 2, page 14, shows a V-TECS DIRECT report for one of the SCANS Proficiencies for Metal Working Occupations. The protocol supports systematic review and updating/supplementing the "snapshots" to ensure continual improvement (TQM) of the guide.

Training Implications

The Indiana model discussed so far has specific application to the education and training community. The Proficiencies have been used as part of an Assessment Protocol to support scenario based assessments. The scenarios represent a real-time situation on the job and the person being assessed performs as if they were a real employee. The protocol, in its most ideal application, would be applied in school-to-work or youth apprenticeship situations where the assessment would be conducted as part of workplace-based training.

Furthermore, several states as well as at least four other multi-state consortiums do similar work using similar processes. These authors believe that the results of these efforts could be used as a source for writing descriptions for the DOT/SOC effort.

Workforce Entry, Reentry, or Empowerment:

Several years ago Indiana established 16 Workforce Development Centers in their SDAs. Each Workforce Development Center has two counselors who were provided with a wide variety of training. The authors of this paper shared major responsibility for training the counselors in conducting occupational analysis, performing assessments based on employer demand, and counseling for employment security. This training used the standard V-TECS duty and task list to identify performance skills required by employers and possessed by potential employees. As a result, clients of the Workforce Development Centers were provided an opportunity to "match" their skills against those required by employers and, thus, to put them into a position of advantage when applying for a job.

In addition, the Workforce Development Centers provided a wide range of assessment from aptitude and interests to employability skills. The output of this service provided the opportunity for a client developed and maintained "portfolio" that could be used throughout life. This concept of "one-stop-shopping" has been reinforced recently through the provision of grants from the U.S. Department of Labor to selected states, Indiana included.

The occupational analysis training for the Workforce Development Center counselors included five days of classroom-type, hands-on instruction on the process of conducting occupational analysis and using computerized databases including V-TECS DIRECT. After these five days, the counselors spent two, four day (eight days total) on-site sessions conducting occupational analysis in various Indiana businesses and industries. These occupational analyses used V-TECS duty and task lists and included an analysis of the basic skills (reading, writing, speaking, listening, and mathematics) required to perform the tasks. The resulting report was suitable for establishing worker upgrade training and several of the businesses and industries used the reports in support of grant applications to the Indiana Department of Commerce for Workforce 2000 training grants.

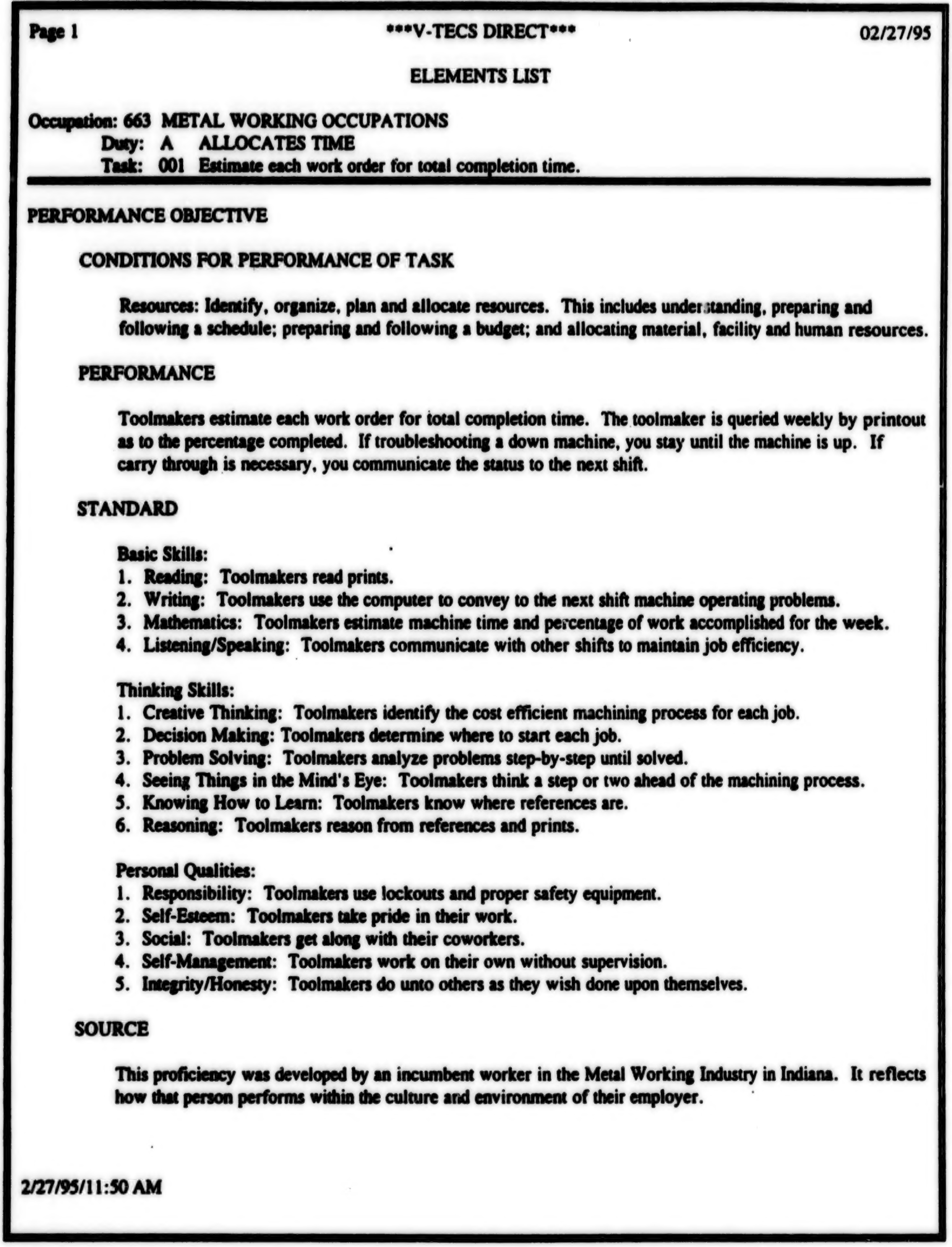
The counselors have continued to conduct occupational analysis in business and industry. The authors believe that opportunity is lost when initiatives like this occur in the states and there is no vehicle to capture this information to analyze, review, and revise standard occupational definitions.

What This Means to the SOC Advisory Panel

The work described in the previous pages would not have occurred had the authors not had a strong experience base in working with the literacy and training needs of business and industry. The authors of this paper count over 150 specific instances where they have worked in an industrial setting with labor and management to identify training needs, to reconfigure job descriptions, to identify literacy skills required of the job, and to develop contextual and specific training for employers that would increase their competitiveness.

The purpose for describing the authors experience, particularly in Indiana, is to illustrate the results of using labor market information and of working in business and industry by members of the training community to better meet the work force supply needs of America. When unemployment was relatively high, the authors work addressed the issue of transferability of skills. When unemployment was relatively low, the focus was to train or retrain for better fits given technological changes. Under both conditions, the focus has been on working with employers to identify the need and working with training providers and placement agencies to meet these needs. Several other states have or are setting up processes similar to the one described in Indiana.

FIGURE 2
SAMPLE PAGE FROM V-TECS DIRECT OF AN INDIANA PROFICIENCY



Page 1 ***V-TECS DIRECT*** 02/27/95

ELEMENTS LIST

Occupation: 663 METAL WORKING OCCUPATIONS
Duty: A ALLOCATES TIME
Task: 001 Estimate each work order for total completion time.

PERFORMANCE OBJECTIVE

CONDITIONS FOR PERFORMANCE OF TASK

Resources: Identify, organize, plan and allocate resources. This includes understanding, preparing and following a schedule; preparing and following a budget; and allocating material, facility and human resources.

PERFORMANCE

Toolmakers estimate each work order for total completion time. The toolmaker is queried weekly by printout as to the percentage completed. If troubleshooting a down machine, you stay until the machine is up. If carry through is necessary, you communicate the status to the next shift.

STANDARD

Basic Skills:
1. Reading: Toolmakers read prints.
2. Writing: Toolmakers use the computer to convey to the next shift machine operating problems.
3. Mathematics: Toolmakers estimate machine time and percentage of work accomplished for the week.
4. Listening/Speaking: Toolmakers communicate with other shifts to maintain job efficiency.

Thinking Skills:
1. Creative Thinking: Toolmakers identify the cost efficient machining process for each job.
2. Decision Making: Toolmakers determine where to start each job.
3. Problem Solving: Toolmakers analyze problems step-by-step until solved.
4. Seeing Things in the Mind's Eye: Toolmakers think a step or two ahead of the machining process.
5. Knowing How to Learn: Toolmakers know where references are.
6. Reasoning: Toolmakers reason from references and prints.

Personal Qualities:
1. Responsibility: Toolmakers use lockouts and proper safety equipment.
2. Self-Esteem: Toolmakers take pride in their work.
3. Social: Toolmakers get along with their coworkers.
4. Self-Management: Toolmakers work on their own without supervision.
5. Integrity/Honesty: Toolmakers do unto others as they wish done upon themselves.

SOURCE

This proficiency was developed by an incumbent worker in the Metal Working Industry in Indiana. It reflects how that person performs within the culture and environment of their employer.

2/27/95/11:50 AM

FINDINGS AND IMPLICATIONS

The First Task

The first task that the designers of the new SOC will have to face is determining the framework for separating out or classifying the various industries, occupations, clusters, and jobs that exist in the workplace. They will have to decide whether they will invent a totally new structure or build on what already exists. In our opinion, there is only one answer, and that is to build on what already exists. While a new structure might be nice, the cost in developing it from scratch would be prohibitive, not to mention the inconvenience to those who already use the current system. More importantly, it is our opinion that the existing systems are reasonably sound, the major fault being that there are too many. Consequently, we recommend that the new SOC become what it was supposed to be from day one: the crosswalk, or better yet, the single system that replaces all other occupational classification systems currently in place. To be more accurate, what we are recommending is that SOC become the system or framework for consolidating the OES survey-based matrix, OES survey occupational codes and titles, and the current census code. We think that there are good elements in each of these that could be condensed around the OES matrix to build one system with three to four levels of specification around some 600 occupational clusters organized under 12 to 14 major occupational families. We believe that the Prototype Skills-Based Job Family Matrix is an excellent place to start as a framework. The classification systems used by the U.S. military and the federal government should be maintained since they serve highly specialized audiences.

Defining Occupational Skill Clusters

The most important issue to be faced in this endeavor is how to define the industrial or occupational clusters. Certain assumptions that are being thrown by several writers simply don't hold water out where the rubber meets the road. One such assumption is that all occupations can be reduced to some 17-20 occupational skill clusters in which people can be taught and certified as being competent. The facts are that all occupations can be easily grouped into about 10 - 20 occupational or industrial families, but to assume that meaningful instruction, training, and skills certification can occur at this level is simply not feasible or practical.

For the record, the vocational and technical education community has had this occupational cluster discussion for many years. In fact, the Office of Adult and Vocational Education, U. S. Department of Education had this same discussion about twenty years ago when Dr. Sidney Marland's Career Education concept was in vogue. His office conducted several research projects which resulted in the identification of some fifteen clusters. Today most state vocational agencies operate under six - eight broad program categories, as illustrated in Figure 3, page 17. These eight categories have their roots in the U.S. Department of Education coding structures for reporting data on programs being operated within states. However, these six to eight categories do not assume that anyone is competent at a broad cluster level since this level is viewed as the point at which the "all about the industry" concepts are taught. Competence is taught and/or certified at an occupation cluster or occupational specialty level based on successful completion of a program or certificate examination (general to specific continuum needed for exploring occupations and becoming certified to enter, reenter, or become empowered in the workforce). This means that quality education and training resulting in meaningful certification of verifiable work based skills, does not begin to emerge until you reach the second or third tier of any given occupational or programmatic classification system.

This is especially true when assessment and certification of competence is introduced into the equation as required in the 22 National Skill Standards Projects and as inferred in the School-to-Work Opportunities Act. Meaningful assessment and certification of work based competence cannot occur until one can clearly define an occupation in terms of work activities and/or skills or what one has to know and be able to do in the performance context of that occupational specialty, occupation or occupational cluster.

FIGURE 3
Typical Way of Organizing Vocational Technical Education In Most States as Summarized by the American Vocational Association In a Recent Brochure Describing this Enterprise

Areas of Study

The hundreds of programs available to vo-tech students usually fall into these eight major areas of study:

☐ Health occupations, such as nursing, medical and dental assistants and radiologic technicians.
☐ Business education, including accounting, office occupations and business management programs.
☐ Trade and industrial education, which imparts occupational skills in a range of trades, including auto mechanics, construction, manufacturing, graphic arts and cosmetology.
☐ Agriculture, including horticulture, agricultural mechanics and agribusiness.
☐ Marketing education, including general merchandising and the marketing of apparel and accessories, real estate and financial, business and personal services.
☐ Technology education, including engineering, architecture, drafting, electronic communications, graphic arts, biotechnology, and transportation.
☐ Home economics, which encompasses consumer and homemaking education as well as occupational fields such as food services and professional child care.
☐ Technical education, which involves instruction at the postsecondary level in a variety of technical occupational fields, such as communications, engineering-related technologies and computer sciences.

Source: American Vocational Association "Vocational Technical Education Today" (Brochure). (1994) Alexandria, Virginia, Page 3.

If there is one thing we have learned from our twenty plus years of experience in this business, and as illustrated in the Indiana example, is that work activities, duties, tasks, and skills have little meaning unless they are treated in the context of a given application and that application is normally within a group of jobs or occupations that are closely related. Without this rationale, meaningful analysis, research, and documentation cannot be provided with any degree of accuracy, reliability, or validity to meet, for example, the requirements of the Americans With Disabilities Act (ADA) as well as other applicable civil rights statutes. The flow must be from broad occupational clusters that provide a rationale for what follows and to allow for valid career exploration to a specific level that allows for meaningful certification. Several of the skill standards papers also support this contention. Kenneth Pearlman says it best when discussing the issue of whether we can go to a totally skills-based system centered around basic and cross functional skills only. His conclusion is that we cannot because when we generalize at this level of definition, every occupation begins to look alike. He contends that we will have to have a system that has skill statements as well as generalizable work activities since it is the work activities that provide the occupational relatedness which is the element that creates the distinction in and among the various occupations.

The Need for Definitions and Relationships Within Occupational Families

Before meaningful work can begin on the SOC, its developers should arrive at a set of operational definitions to guide their work. For example, when the term "industry-wide" is used, one group will think of the construction industry, the electronics industry, or the manufacturing industry while another group will think of the residential construction industry or the commercial construction industry. To others residential or commercial construction are occupations or jobs while to others, occupations or jobs are riveter, roofer, painter, framer, etc. In arriving at definitions, you'll never find a set of definitions that everyone will totally agree with. Who cares? What is important is that the organization calling the shots has its own set of operational definitions for the conduct of its own dialog and its own work.

Thoughts About How Occupations Relate

Experience has also revealed that industry-wide clusters don't sort out as easily and as defensibly as do occupational clusters when assessment becomes the focal point or purpose. Admittedly, there are groupings of occupations that equal an industry. Industries play an important part in relation to the SOC data collection since we would have been lost without industry staffing patterns developed through the OES survey programs which provide a way for us to identify which occupations exist in which industries.

While some people might not consider the automotive service industry an occupational/skills cluster, the industry cannot employ people successfully under an industry wide concept. Its context or cluster is automotive service and repair with certification based on the identification and validation of competencies in a specialty area of the occupation or at a master technician's level given competence in all specialty areas. The pattern of certification used in this field permits a person to progress from a specialist to a master technician when they are competent in some 560 tasks that have been identified and validated by other master technicians nationwide; consequently, an ASE (Automotive Service Excellence) certified person in any of the areas listed is employable nationwide and is not tied to any one employer, automotive brand name or region of the country. Any occupational classification system that ignores training patterns and standards established by an industry will lead to utter confusion in that industry.

A redesigned occupational/skills cluster classification system, must make provisions within the occupational/skills cluster for the occupations that are represented in the major sub-divisions of the skilled occupation as defined by experts in the industry. As an example, the automobile technician occupation involves eight major sub-divisions, engine repair, automotive transmission, manual transmission and drive train, suspension and steering, brakes, electrical system, heating and air-conditioning, and engine performance. Persons work as specialists in one or more of these specialized areas and have a high level of mobility based on their level of competence and the needs of the workplace. In heating, air conditioning, and refrigeration, our V-TECS National Skill Standards Project business and industry partners tell us that their technicians work in the residential, light commercial, and commercial areas or they specialize in refrigeration or work as power engineers or operators in large self-contained facilities.

What Analysis Processes Should Be Used

There is no one analysis process that will fit every occupational classification in every business or industry because of the way each business and/or industry is structured. First, it must be recognized that there are occupations which are structured in very linear patterns where one skill builds on another in an almost vertical or hierarchal pattern. Occupations such as the specialty areas in heating, air conditioning and refrigeration tend to fit this mold. These workers tend to diagnose system and address failures. They tend to install, maintain, repair, and operate highly technical systems. On the other hand, a person who specializes in electronics has skills that are supportive to many occupational clusters such as HVAC, automotive, computer repair, manufacturing, etc. The same is true for administrative support type occupations.

Certain people want to write off many of the occupational and task analysis processes that have been used very successfully in the past. In their mind they try to draw a parallel between these approaches and Taylorism. They think that since task analysis results in very detailed information about task performance on a task by task basis, that each person will only perform one or two tasks in meaningless, low-paying jobs, such as those previously performed by many workers on an assembly line, or that they will pump gas instead of diagnosing the electrical or fuel system of an automobile. Nothing could be further from the truth. What occupational and task analysis provides is a total description of all aspects of an occupation. It provides the basics upon which the academic skills such as language arts, math, science are derived. V-TECS has even used a modified version of its occupational and task analysis process to identify and to validate a list of generic workplace skills by using business and industry in seventeen states to verify these skills. Occupational and task analysis does the best job of providing the documentation between training and work that is needed to develop reliable criterion referenced and performance based assessment vehicles. Without a good occupational and task analysis which defines what is done, you cannot identify the knowledge and skills involved to any degree of accuracy.

As far as this writer is concerned, the jury is still out on the value of the work being done by ACT under the direction of Dr. Robert Korte. In reading the documentation describing this work, there is little doubt that the processes being used are sound and will stand the test of good research and assessment techniques. However, even if the study proves what it has set out to achieve, which is very possible, the use of generalizable skill statements don't mean much unless they are written in the context of their actual application. V-TECS has learned this lesson through its experience with the Snyder Taxonomy of Essential Skills which is used as a tool to identify academic skills for each occupational area. On the one hand, the Taxonomy is a tremendous tool since it can be used as a crosswalk across occupations and as a vehicle for making judgements about what language, math and science skills are embedded in each occupation so that we can determine what the core skills are in an occupational cluster; however, the skill itself is not mastered until it is practiced in context. Saying someone needs "to be able to solve problems" isn't enough since this concept is practiced very differently in a manufacturing environment as compared to that of a service technician environment. In a manufacturing environment problem solving would be done as a part of a team. In a service environment an automotive, electronic or HVAC technician would most likely solve the problem alone following a specific diagnostic or decision tree process.

Once we know what goes on in the workplace someone has to translate the information into curriculum and assessment tools that insure effective training and certification of skills. Vocational-technical education state leaders, JTPA providers, local instructors, labor and industry trainers and school-to-work providers are the ones who have to do this. Our feeling is that when this type of information gets too general it magnifies the problems of delivering meaningful instruction and training, especially, when developing assessment and certification tools which will stand the legal test are included. That is why so many people buy into the competency or performance based instruction concept since it focuses on using criterion referenced assessment tools that are based on actual workbase activities and standards of performance. Our plea is to involve educators as much as possible and recognize the work that has already been done in this arena by organizations such as V-TECS, Mid-America Vocational Curriculum Consortium (MAVCC), National Occupational Competency Testing Institute (NOCTI), and the competency based instruction and assessment systems in the states of Oklahoma, Arkansas, Ohio, Kentucky, North Carolina, as well as several others. They have already crossed many of these bridges and much can be learned from their experiences; just ask ASE, EIF and NACFAM how valuable their input has been. These organizations know who the real experts are in the conduct of this type of work since these people have spent their time doing it rather than philosophizing about it.

Clusters and Tasks are More Durable Than One Might Think Given Technological Changes

Technology changes but occupational/skills clusters are more durable than many might think. There were carpenters fifty years ago and there will be carpenters fifty years from now; however, they will perform their tasks with new materials and technologies which require different skills and knowledge. In the future, persons presently working in these occupational/skills clusters will probably still be employed in the same occupational family but will be required to obtain upgrade training on an on-going basis in order to stay current. Contrary to popular belief, the tasks that these workers will perform over time will not change that much if they are properly identified and verified to start with. What will change are the materials and technology that drive the processes, not the core tasks that are performed by workers. Another interesting fact about new job formulation is that there are not very many brand new jobs or occupations that emerge that are made up of totally new tasks. What generally happens is that already known skills from three to four existing technologies tend to merge. For example, robotics represents the merger of electronics, pneumatics, mechanics and hydraulics. Moving to teams simply means that everyone has to master more skills.

There is no question that all workers need higher level academic and workplace skills, however, our experience shows that the transportability and generalizability of these skills isn't as clear cut as some would lead us to believe it is. There is strong evidence to suggest that the basic skills, advanced academic skills and SCANS/Workplace Skills should be delivered as a base for all students whether they are college bound or work bound and then be reinforced in the context of the occupation they are to be applied in. These type of skills should become the backbone for a certificate of initial mastery or vehicles such as Indiana's Certificate of Technical Achievement. This is the approach already being used by the state of Oregon and others, who are in the process of implementing CIM/CAM models.

The point of this discussion is that many people are rapidly buying into a philosophy that is based almost entirely on what is occurring in the manufacturing and big business sector of the economy when manufacturing constitutes less than 20% of the workforce and this percentage is still dropping, yet 47% of the current DOT is based on out-dated manufacturing jobs. While the manufacturing sector is moving to a more generalizable context, other sectors of the economy are not. In fact, many service technician occupations are becoming more and more specialized because of the impact of technology and the need for higher order skills. We need to realize that we are not dealing with a one size fits all world of work.

Implications of the Goals 2000 National Skill Standards Board for the SOC/DOT/O*NET

The National Skill Standards Board (NSSB) has been charged with developing a system for clustering occupations. The following points have been extracted from the Goals 2000 legislation.

Section 502, Title V, spells out the purpose of the Board as follows:

> It is the purpose of this title to establish a National Skill Standards Board to serve as a catalyst in stimulating the development and adoption of a voluntary national system of skill standards and of assessment and certification of attainment of skill standards --
>
> (1) that will serve as a cornerstone of the national strategy to enhance workforce skills;
> (2) that will result in increased productivity, economic growth and American economic competitiveness; and
> (3) that can be used in connection with civil rights laws --

Section 504 of Title V spells out the functions of the Board.

> ... the National Board shall identify broad clusters of major occupations that involve one (1) or more than one industry in the United States that share characteristics that are appropriate for the development of common skill standards.

To achieve this task, Congress set a deadline of December 31, 1995, for the National Skill Standards Board to identify those occupational clusters pursuant to Section 504(a) that would represent a substantial portion of the workforce for which the initial sets of skill standards for the clusters identified would be developed. Given this deadline and this provision, it is imperative that those working on the revised SOC, new DOT/O*NET, and NSSB be on the same page regarding the framework to be used for clustering.

Section 508 of Section V in Goals 2000 defines the term skill standard as "a standard that specifies the level of knowledge and competence required to successfully perform work related functions within an occupational cluster."

To those of us who have spent several years doing this type of work, virtually every word in this definition has real meaning in terms of providing clarity for the task at hand. Under this definition skills become the derivative of a formal process of analyzing occupations which means there are at least two levels in the hierarchy of clusters within occupational families or industrial families. What this Law requires is that we look at occupations that group together based on their common work characteristics or skills as opposed to trying to create artificial groupings based on skill statements that have little meaning out of context.

Points of Concern

Some points of concern as we look to develop new concepts of a revised occupational/code structure:

- We need to be careful when we look at model classification systems from other countries. The work force in the United States is much more heterogeneous in terms of race, creed, original nationality, family structure and social attitudes than many of the European and Asian countries that we tend to make comparisons to. In this regard we need to be careful about trying to implement models that are much more limited in scope given that our country is much larger and much more diverse than most of the countries we are looking at. However, we do believe that the International and Canadian model have elements that could inform our process since they are more comprehensive and compatible to our needs than most of the systems used in other countries.

- Equal attention needs to be given to ALL SECTORS of the business and industry community particularly that of the small business sector where most of the new jobs are being created. These sectors are not as capable of investing heavily in training since they have very limited resources for this purpose; however, they do benefit significantly from occupational classification systems.

- No system of occupational/skills clusters can ignore industry employment trends or policies or the educational programs that prepare people for employment. There is little question that the number of low skilled production occupations and the number employed in them will continue to decline. There is little question that those occupations that the SOC developers should address first should come from those industries and occupations with the largest numbers of skilled workers in the areas of greatest change due to the impact of technology.

What Classification System(s) Best Serve the Purpose of Grouping Occupations

To address the questions of what occupational classification system best serves as a base for the grouping of occupations using a skills-based concept, several occupational classification systems were reviewed to gain a better grasp of what each system does or does not provide. This was necessary for these authors since we do not use the systems on a daily basis. To facilitate the process of focusing on each system, a format was developed which provides an extract of the major codes and titles that are representative of the various levels of each system. In addition, at least one breakout for each subdivision or tier was included to better illustrate the various levels included in each system. For each system the authors have provided comments regarding how useful each system has been or could be in terms of accurately defining occupations. Those systems reviewed include the following:

- Standard Occupational Classification (SOC)
- Occupational Employment Survey (OES)
  -- OES Survey-Based Matrix Occupational Codes and Titles
  -- OES Survey Occupational Codes and Titles
- Classification of Instructional Programs (CIP)
- Database of Occupational Titles (DOT) Content Model
- NOICC Master Crosswalk
- Prototype Skills-Based Job Family Matrix

STANDARD OCCUPATIONAL CLASSIFICATION (SOC) SYSTEM

The original purpose of the SOC was to serve as an umbrella for all other occupational classification systems. At best it has become a framework for crosswalking existing systems. The SOC could become a very useful system for creating occupational skill clusters if certain modifications were made. However it needs to be updated and many of its titles should be merged. A close examination of the next page illustrates why the issue of occupational classification is so complex as well as why industry-wide clusters using broad generalizable skills won't work given the vast number of occupational/job titles and the variety of settings in which work is performed. Figure 4 shows the major categorical titles for the SOC while Figure 5, page 24, provides an excerpt illustrating a sample set of sub-categories. The SOC contains a coding system and nomenclature that covers all occupations in which work is performed for pay or profit, including work performed in family operated enterprises where direct remuneration may not be made to family members.

The SOC is structured on a four-level system with 20 Divisions (plus military and miscellaneous), 58 Major Groups, 222 Minor Groups, and 538 Unit Groups. (Major groups, minor groups and unit groups are indicated by a two-, three-, or four-digit code respectively.) Each level represents groupings in successively finer detail which enables the user to tabulate or analyze data on different levels of aggregation. Residual categories are established, where necessary, at all levels to handle groups of occupations that do not warrant separate identification or do not fit into one of the specific groups.

FIGURE 4
Standard Occupational Classification (SOC) System

Major Code Number	Major Categorical Titles
11, 12, 13, 14	Executive, Administrative and Managerial Occupations
16	Engineers, Surveyors and Architects
17-18	Natural Scientist and Mathematicians
19, 20, 21	Social Science, Social Workers, Religious Workers and Lawyers
22, 23, 24, 25	Teachers, Librarians, Counselors
26, 27, 28	Health Diagnostic and Treating Practitioners
29, 30	Registered Nurses, Pharmacists, Dietitians Therapists, and Physicians Assistant
31, 32, 33, 34	Writers, Artists, Entertainers, Athletics
36	Health Technologists and Technicians
37, 38, 39	Technologists and Technician Except Health, Engineering and Science
40, 41, 42, 43, 44	Marketing and Sales Occupations
45, 46, 47	Administrative Support Occupations, including Clerical
50, 51, 52	Service Occupations
55, 56, 57, 58	Agricultural Forestry and Fishing Occupations
60, 61	Mechanics and Repairers
63, 64, 65	Construction and Extractive Occupations
67, 68,69	Precision and Production Occupations
71, 73, 74, 75, 76, 77, 78	Production Worker Occupations
81, 82, 83	Transportation and Material Moving Occupations
85, 86, 87	Handlers Equipment Cleaners Helpers and Launders
91	Military Occupations
99	Miscellaneous Occupations

FIGURE 5
Typical Listings Within a SOC Category

Precision Production Occupations	
67	SUPERVISORS; PRECISION PRODUCTION OCCUPATIONS
68	PRECISION PRODUCTION OCCUPATIONS
681-2	PRECISION METAL WORKERS
6811	Tool and Die Makers
6812	Precision Assemblers (Metal)
6813	Machinists
6814	Boilermakers
6816	Precision Grinders, Filers, and Tool Sharpeners
6817	Patternmakers and Model Makers (Metal)
6821	Lay-out Workers
6822	Precision Hand Molders and Shapers (Jewelers)
6823	Engravers
6824	Sheet Metal Workers
6829	Miscellaneous Precision Metal Workers
683	PRECISION WOODWORKERS
6831	Patternmakers and Model Makers, Wood
6832	Cabinet Makers and Bench Carpenters
6835	Furniture Finishers
6839	Miscellaneous Precision Woodworkers
684	PRECISION PRINTING OCCUPATIONS
6841	Precision Typesetters
6842	Precision Lithographers and Photoengraver
6844	Bookbinders
6849	Miscellaneous Precision Printing Occupations
685	PRECISION TEXTILE, APPAREL AND FURNISHINGS WORKERS
6852	Tailors and Dressmakers, Hand
6853	Upholsterers
6854	Shoemakers and Leather Workers Repairers
6855	Precision Laundering, Cleaning, and Dyeing Occupations
6856	Apparel and Fabric Patternmakers
6859	Miscellaneous Precision Apparel and Fabric Workers
686	PRECISION WORKERS; ASSORTED MATERIALS
6861	Precision Hand Molder sand Shapers (Except Jewelers)
6862	Precision Patternmakers, Lay-out Workers and Cutters
6863	Detail Design Painters and Decorators
6864	Optical Goods Workers
6865	Dental Laboratory Technicians
6866	Gem and Diamond Working Occupations
6867	Precision Electrical and Electronic Equipment Assemblers
6868	Photographic Process Workers
6869	Miscellaneous Precision Workers, Not Elsewhere Classified
687	PRECISION FOOD PRODUCTION OCCUPATIONS
6871	Butchers and Meat Cutters
6872	Bakers
6873	Matchmakers (Candymakers, Cheesemakers, Etc.)
6879	Miscellaneous Precision Food Workers
688	PRECISION INSPECTORS, TESTERS, AND RELATED WORKERS
6881	Precision Inspectors, Testers, and Graders
6882	Precision Adjusters and Calibrators

OCCUPATIONAL EMPLOYMENT SURVEY STRUCTURE

Of the classification systems reviewed for this paper, the OES Occupational Structure has the most to offer for the restructuring of the SOC since there are already crosswalks available through NOICC that show its relationship to the SOC, SIC, CIP, and the OES codes and titles. The OES is currently used to collect Labor Market information through the OES survey of employers as well as a base for the conduct of the census survey; consequently, it is the most current of all systems. Its focus on worker roles makes it very useful since some of the titles already being used do an excellent job of clustering like types of work from different industries together. Since it is basically an occupational titles classification system, it would be very useful in helping to bring the current SOC and DOT/O*NET groupings down to a manageable number. Figure 6 illustrates the major OES Groupings, while Figure 7, page 26, provides breakouts for a typical sub set. The OES tables contain a listing arranged in ascending numerical order of all five-digit OES codes and titles.

FIGURE 6
Occupational Employment Survey (OES) Occupational Structure

Major Code		Title
10000	I.	Managerial and Administrative Occupations
20000 and 30000	I.	Professional, Paraprofessional, and Technical Occupations
40000	I.	Sales and Related Occupations
50000	V.	Clerical and Administrative Support Occupations
60000	V.	Service Occupations
70000	I.	Agricultural, Forestry, Fishing, and Related Occupations
80000 and 90000	I.	Production, Construction, Operating, Maintenance, and Material Handling Occupations

FIGURE 7
Sample OES Subsets

85000	C. MECHANICS, INSTALLERS, AND REPAIRERS
85100	1. SELECTED MACHINERY AND RELATED MECHANICS, INSTALLERS, AND REPAIRERS
85110	MACHINERY MAINTENANCE MECHANICS
85112	MACHINERY MAINTENANCE MECHANICS, TEXTILE MACHINES
85113	MACHINERY MAINTENANCE MECHANICS, SEWING MACHINES
85116	MACHINERY MAINTENANCE MECHANICS, MARINE EQUIPMENT
85117	UNDERGROUND MINE MACHINERY MECHANICS
85118	MACHINERY MAINTENANCE MECHANICS, WATER OR POWER GENERATION PLANT
85119	ALL OTHER MACHINERY MAINTENANCE MECHANICS
85123	MILLWRIGHTS
85126	REFRACTORY MATERIALS REPAIRERS, EXCEPT BRICK MASONS
85128	MACHINERY MAINTENANCE WORKERS
85132	MAINTENANCE REPAIRERS, GENERAL UTILITY
85300	2. SELECTED MOBILE EQUIPMENT MECHANICS, INSTALLERS, AND REPAIRERS
85302	AUTOMOTIVE MECHANICS
85305	AUTOMOTIVE BODY AND RELATED REPAIRERS
85308	MOTORCYCLE REPAIRERS
85311	BUS AND TRUCK MECHANICS, AND DIESEL ENGINE SPECIALISTS
85314	MOBILE HEAVY EQUIPMENT MECHANICS, EXCEPT ENGINES
85317	RAIL CAR REPAIRERS
85321	FARM EQUIPMENT MECHANICS
87000	D. CONSTRUCTION TRADES AND EXTRACTIVE OCCUPATIONS, EXCEPT MATERIAL MOVING
87100	1. SELECTED CARPENTRY AND RELATED WORKERS
87102	CARPENTERS
87105	CEILING TILE INSTALLERS AND ACOUSTICAL CARPENTERS
87108	DRYWALL INSTALLERS
87111	TAPERS
87114	LATHERS
87121	BRATTICE BUILDERS
87200	2. SELECTED ELECTRICAL AND RELATED WORKERS
87202	ELECTRICIANS

CLASSIFICATION OF INSTRUCTIONAL PROGRAMS (CIP)

One of the best classification systems for creating meaningful occupational clusters is not even an occupational classification system. It is the Classifications of Instructional Programs, developed by the National Center for Education Statistics, U. S. Department of Education. At first glance the typical reader would not agree with this contention; however, when the program titles that lead to employment through the traditional higher education/university degree route are stripped away, what is left is a set of codes and titles that with a few word changes rapidly becomes a structure for defining clusters using broad based occupational groupings. Those familiar with how the better vocational and technical education programs are actually operated know that these programs have always been organized around clusters of occupational titles. By looking at Figure 10 one can readily see how clusters can be easily formed at the four and/or six digit level. If you simply count the four digit codes for technical programs in the current CIP manual, you arrive at approximately 70 occupational clusters. If the six digit titles are used, the total falls between 150-160 titles. Figure 9 illustrates how descriptions are written for each code which provides excellent insight into what the programs are about.

The reason the CIP is so useful is that Dr. Robert Morgan and his fellow developers at NCES came to this task with very strong occupational education backgrounds. They also knew how important it was to make the codes and titles as occupationally descriptive as possible. They developed the CIP model after studying and borrowing from each of the existing structures described earlier in this paper. They also worked very closely with NOICC to insure compatibility which is best illustrated in the NOICC Units of Analysis Crosswalk. Another plus for the 1990 CIP is that it is reasonably current, consequently, it closely reflects the composition of today's world of work and can be easily modified as the world of work changes.

Another major advantage of the CIP is that it already contains much of the educational degree/certificate equivalency information built into its descriptions; consequently, a matrix could be easily created showing the traditional education and training requirements for all occupations from top management down through occupational titles that represent the basic threshold skills needed to enter any field at any point. The CIP is a very easy document to interpret since it has a six-digit, three-level structure representing a definite hierarchy in terms of broad to more specific titles. If further definition is needed, two digits could be added to the present six-digit structure to create an eight-digit structure which could include even more specific occupational or job titles represented within a cluster. This could be the DOT/SOC codes and titles. Please refer to Figures 10 and 11 for specific details regarding the major codes and titles for CIPs, typical sub-titles. Sample definitions for the four and six digit codes are shown at Figure 9. This is a very useful feature and should be incorporated into the SOC and Dot. While we do not expect the SOC Advisory Committee to use the CIP as its classification much can be gleaned form it in terms of structure, meaningful descriptions, and coherence between systems. Figure 12 illustrates how V-TECS relates its occupational task list to the CIP.

FIGURE 8
United States Department of Education
1990 Classification of Instructional Program Codes and Titles

Codes and Titles for All Program Groups		Codes and Titles Which Cover the Majority of the Occupational Program or Clusters that Would Likely Occur in a Skill Standards Environment	
01	Agricultural Business and Production	01	Agricultural Business and Production
02	Agricultural Science	02	Agricultural Science
03	Conservation and Renewable Natural Resources	03	Renewable and Natural Resources
04	Architectural and Related Programs		
05	Area Ethnic and Cultural Studies		
08	Marketing Operations/Marketing Distribution	08	Marketing and Distribution Occupations
09	Communications		
10	Communications Technologies	10	Communication Technology Occupations
11	Computer and Information Sciences	11	Computer and Information Sciences Occupations
12	Personal and Miscellaneous Services	12	Personal and Miscellaneous Occupations
13	Education		
14	Engineering		
15	Engineering - Related Technologies	15	Engineering and Engineering Related Technology
16	Foreign Languages and Literature		
19	Home Economics (*** Degree or Non-paid)		
20	Vocational Home Economics/Consumer and Homemaking Programs	20	Vocational Home Economics and Consumer Occupations
21	Technology Education/Industrial Arts	21	Technology Education
22	Law and Legal Services		
23	English and Literature/Letters		
24	Liberal Arts and Sciences, General Studies and Humanities		
25	Library Science		
26	Biological Science/Life Science		
27	Mathematics		
28	Reserve Officers Training Corps	29	Military Technology Occupations
29	Military Technologies		
30	Multi-Interdisciplinary Studies	31	Parks, Recreations, Leisure & Fitness Occupations
31	Parks Recreations Leisure and Fitness Studies		
32	Personal Improvement and Leisure Program/Basic Skills		
33	Citizenship Activities		
34	Health Related Knowledge and Skills		
35	Interpersonal and Social Skills		
36	Leisure and Recreational Activities		
37	Personal Awareness and Self-Improvement		
38	Philosophy and Religion		
39	Theological Studies and Religious Vocation		
40	Physical Sciences	41	Science Technology Occupations
41	Science Technology		
42	Psychology	43	Protective and Legal Service Occupations
43	Protective Services		
44	Public Administration and Science		
45	Social Science and History	46	Construction Trades
46	Construction Trades	47	Mechanics and Repairs
47	Mechanics and Repairs	48	Precision and Production Occupation
48	Precision Production Trades	49	Transportation and Material Movers
49	Transportation and Material Movers	50	Applied Art and Design Occupations
50	Visual and Performing Arts	51	Health Related Occupations
51	Health Professions and Related Services	52	Business Management and Admn Service Occupations
52	Business and Management and Administrative Services		
53	High School/Secondary Diploma Certificates		

Source: United States Department of Education. Classification of Instructional Programs. (1990). Washington, DC. Pages 1 - 48

FIGURE 9
Typical Descriptors for Each Code and Title from the Classification of Instructional Programs

15.06 **Industrial Production Technologies.** A group of instructional program that prepare individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using industrial processes.

. . . .

- 15.0603 Industrial/Manufacturing Technology/Technician. An instructional program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using industrial manufacturing system and processes. Includes instruction in design and prototype testing, instrument calibration, operational and maintenance procedures, operational diagnosis and repair, applications to specific system and products, and report preparation.

- 15.0607 Plastics Technology/Technician. An instructional program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using industrial polymers. Includes instruction in the principles of macromolecular chemistry, polymerization and plastic manufacturing processes and equipment, design, and operational testing procedures, equipment maintenance and repair procedures, safety procedures, applications to specific products, and report preparation.

- 15.0611 Metallurgical Technology/Technician. An instructional program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and metallurgists engaged in developing and using industrial metals and manufacturing processes. Includes instruction in principles of metallurgy, related manufacturing systems, laboratory techniques, testing and inspection procedures, instrument calibration, system and equipment maintenance and repair, applications to specific processes, and report preparation.

- 15.0699 Industrial Production Technologies/Technicians, Other. Any instructional program in industrial production and technologies not described above.

Source: United States Department of Education. Classification of Instructional Programs. (1990). Washington, DC. Pages 96-97.

FIGURE 10
Typical Sub-Listings from the Classification of Instructional Programs (CIP) *

15. ENGINEERING-RELATED TECHNOLOGIES

15.01 Architectural Engineering Technology

15.0101	Architectural Engineering Technology/Technician

15.02 Civil Engineering/Civil Technology

15.0201	Civil Engineering/Civil Technology/Technician

15.03 Electrical and Electronic Engineering-Related Technology

15.0301	Computer Engineering Technology/Technician
15.0303	Electrical, Electronic and communications Engineering Technology/Technician
15.0304	Laser and Optical Technology/Technician
15.0399	Electrical and Electronic Engineering-Related Technologies/Technicians, Other

15.04 Electromechanical Instrumentation and Maintenance Technology

15.0401	Biomedical Engineering-Related Technology/Technician
15.0402	Computer Maintenance Technology/Technician
15.0403	Electromechanical Technology/Technician
15.0404	Instrumentation Technology/Technician
15.0405	Robotics Technology/Technician
15.0499	Electromechanical Instrumentation and Maintenance Technologies/Technicians, Other

15.05 Environment Control Technologies

15.0501	Heating, Air Conditioning and Refrigeration Technology/Technician
15.0503	Energy Management and Systems Technology/Technician
15.0505	Solar Technology/Technician
15.0506	Water Quality and Wastewater Treatment Technology/Technician
15.0507	Environmental and Pollution Control Technology/Technician
15.0599	Environmental Control Technologies/Technicians, Other

15.06 Industrial Production Technologies

15.0603	Industrial/Manufacturing Technology/Technician
15.0607	Plastics Technology/Technician
15.0611	Metallurgical Technology/Technician
15.0699	Industrial Production Technologies/Technicians, Other

15.07 Quality Control and Safety Technologies

15.0701	Occupational Safety and Health Technology/Technician
15.0702	Quality Control Technology/Technician
15.0799	Quality Control and Safety Technologies/Technicians, Others

. . . .

(More listed, but not used)

Source: United States Department of Education. Classification of Instructional Programs. (1990). Washington, DC. Pages 15-16.

FIGURE 11
Typical Sub-Listing from the Classification of Instructional Programs (CIP)

47. MECHANICS AND REPAIRERS

47.06 Vehicle and Mobile Equipment Mechanics and Repairers

47.0603 Auto/Automotive Body Repairer
47.0604 Auto/Automotive Mechanic/Technician
47.0605 Diesel Engine Mechanic and Repairer
47.0606 Small Engine Mechanic and Repairer
47.0607 Aircraft Mechanic/Technician/Airframe
47.0608 Aircraft Mechanic/Technician, Powerplant
47.0609 Aviation Systems and Avionics Maintenance Technologies/Technician
47.0610 Bicycle Mechanic and REPAIRER
47.0611 Motorcycle Mechanic and REPAIRER
47.0699 Vehicle and Mobile Equipment Mechanics and Repairers, Other

48. PRECISION PRODUCTION TRADES

48.01 Drafting

48.0101 Drafting, General
48.0102 Architectural Drafting
48.0103 Civil/Structural Drafting
48.0104 Electrical/Electronics Drafting
48.0105 Mechanical Drafting
48.0199 Drafting, Other

48.02 Graphic and Printing Equipment Operators

48.0201 Graphic and Printing Equipment Operator, General
48.0205 Mechanical Typesetter and Composer
48.0206 Lithographer and Platemaker
48.0208 Printing Press Operator
48.0211 Computer Typography and Composition Equipment Operator
48.0212 Desktop Publishing Equipment Operator
48.0299 Graphic and Printing Equipment Operators, Other

48.05 Precision Metal Workers

48.0501 Machinist/Machine Technologies
48.0503 Machine Shop Assistant
48.0506 Sheet Metal Worker
48.0507 Tool and Die Maker/Technologies
48.0508 Welder/Welding Technologies
48.0599 Precision Metal Workers, Other

49. TRANSPORTATION AND MATERIALS MOVING WORKERS

Source: United States Department of Education. Classification of Instructional Programs. (1990). Washington, DC. Pages 15-16.

FIGURE 12
Excerpts from the V-TECS Product Priority Matrix Using CIP Codes And Program/job Titles

1990 CIP	OCCUPATIONAL TITLE
15	**ENGINEERING RELATED TECHNOLOGIES**
15.03	ELECTRICAL AND ELECTRONIC ENGINEERING RELATED TECHNOLOGY
15.0304	Laser System Technician
15.04	ELECTROMECHANICAL INSTRUMENTATION AND MAINTENANCE TECHN
15.0401	Biomedical Equipment Technology
15.0402	Computer Equipment Repair
15.0403	Electronic Mechanical Technician
15.0404	Instrument Repair Technician
15.0405	Robotics Technician
47	**MECHANICS AND REPAIRER OCCUPATIONS**
47.03	INDUSTRIAL EQUIPMENT MAINTENANCE AND REPAIRER
47.0302	Heavy Equipment Mechanic
47.0303	Industrial Maintenance Mechanic
47.06	VEHICLE AND MOBILE EQUIPMENT MECHANICS AND REPAIRS
47.0603	Auto Body Repairer
47.0604	Auto Mechanic
47.0604	Diesel Engine Mechanic (Revision)
47.0604	Auto Mechanics: Suspension Systems, Brakes & Steering
47.0604	Auto Engine Performance Technician
47.0604	Auto Engine and Drive Train Technician
47.0604	Auto Air Conditioning and Electrical System Technician
47.0606	Small Engine Repairer
47.0608	Motorcycle Mechanic
48	**PRECISION PRODUCTION TRADES OCCUPATIONS**
48.05	PRECISION METAL WORKERS
48.0503	Machine Tool Operation
48.0503	Computerized Numerical Control
48.0503	Machinist (Revision)
48.0506	Sheet Metal Worker (Revision)
48.0507	Tool and Die Maker
48.0508	Welder (Revision)

What Can We Learn From The Classification of Instructional Programs About Organizing Occupations

The set of titles shown have been derived by broadening the context of the Occupational Titles shown on the right side of Classification of Instructional Programs as illustrated in Figure 8, page 28. By making a few word changes and adding such terms as arts, finance, education and training, we have developed a schema that also allows for the inclusion of management and higher level clusters. It's interesting how closely this list parallels the prototype system developed for DOL using the Canadian model as a base.

CIP Codes	MODIFIED CIP TITLES
01, 02, 03	AGRICULTURAL, FORESTRY, NATURAL RESOURCE OCCUPATIONS
08	MARKETING AND DISTRIBUTIVE OCCUPATIONS
	PERSONAL SERVICE AND MISCELLANEOUS OCCUPATIONS
09, 10	ARTS AND COMMUNICATION OCCUPATIONS
14, 14, 15, 41	ENGINEERING AND SCIENCE RELATED OCCUPATIONS
08, 20, 31	HOSPITALITY AND TOURISM OCCUPATIONS
22, 43	PROTECTIVE AND LEGAL SERVICES OCCUPATIONS
46	CONSTRUCTION TRADES OCCUPATIONS
47	MECHANICS/TECHNICIANS, INSTALLERS, REPAIRER SERVICE OCCUPATIONS
48	PRECISION AND PRODUCTION OCCUPATIONS
49	TRANSPORTATION AND MATERIAL MOVING OCCUPATIONS
51	HEALTH OCCUPATIONS
44, 52	BUSINESS, FINANCE MANAGEMENT AND ADMINISTRATION
13	EDUCATION AND TRAINING OCCUPATIONS

To take this concept one step further, the following four-, six-, or eight-digit system could emerge whereby clusters could be developed for at least two levels under each family.

00.	Occupational Family/Industry	SOC LEVEL
00.00	Occupational Cluster/Programs	
00.0000	Occupational Specialties/Clusters/Skills	
00.000000	Occupational Job Titles	DOT LEVEL

This model covers every option with minimum duplication and allows for clusters to emerge at two or more tiers which is extremely important since level of specificity tends to vary based on the industry or occupation being reviewed. Each group could also be arranged or classified as follows:

Level 5 *CEO, Management Administration* - Advanced Degree

Level 4 *Supervisor* - Basic Degree or Advanced Certificate of Mastery

Level 3 *Master Technician/Journeyman Level* - Postsecondary Degree or Certificate of Mastery

Level 2 *Specialist Level* - Postsecondary Certificate of Mastery; Secondary Certificate of Mastery; On-the-Job Training

Level 1 *Trainee Exit Level/Position Entry Level* - Secondary Diploma or Certificate of Mastery

DICTIONARY/DATABASE OF OCCUPATIONAL TITLES

Given that the decision has been made to design a Database of Occupational Titles (Figure 13, page 36) instead of revising the Dictionary of Occupational Titles, these authors have chosen to endorse the concept and simply comment on the importance of each element of the proposed data base rather than critique an out-of-date DOT. At V-TECS the DOT is used to assign codes to occupational analysis outcomes where applicable and meaningful. Since V-TECS has historically conducted occupational analysis around what it calls occupational domains or clusters, which are simply groupings of occupational job titles that are similar enough to serve as a solid and reliable research base. The DOT is used to indicate that a given V-TECS domain relates to certain DOTs; not as a concrete title to develop around. In the earlier years, V-TECS used the Vocational Preparation and Occupations (VPO), developed by the National Occupational Information Coordinating Committee (NOICC), as a primary source for crosswalking the Office of Education (OE) Codes and Titles and the Dictionary of Occupational Titles since it was already formatted to provide a direct crosswalk between these two code structures as well as across other coding structures such as SOC, OES, etc. Today V-TECS uses the VPO successor, the NOICC Master Crosswalk electronic database for the same purpose.

These authors totally support moving the DOT information to the O*NET database environment. The APDOT has done an outstanding job of thinking through the various elements and descriptors that should be included in the database; however, when each sub-descriptor is studied carefully, there appears to be some potential for overlap. Consequently, further consolidation should be seriously considered given the potential magnitude of this database.

Another thing very critical to the marketing and usability of this database is that it be developed around a software shell that treats each set of descriptors as independent elements so that each user can use as little or as much information in the O*NET system as they need depending on how they intend to use the information. For instance, while we believe labor market information is very important, we don't use it on a daily basis to the degree we would worker aptitudes, work content, or outcome information. The worst thing you can do to a database of this importance is to try to satisfy everyone's needs to the degree that you overload its capabilities to the point that no one can use it. When you do so, you wind up satisfying no one since every element added means more disk space occupied with a direct slowdown in access time.

Using DOT Information

In the early 1980s, a CETA Part B grant was awarded to the Department of Agricultural and Extension Education, Michigan State University, to perform occupational analysis in five occupational areas. The Michigan Employment Security Commission, Occupational Analysis Field Center, was a partner in this project. Duty and task lists were fabricated using a combination of V-TECS data and the raw data collected for the Dictionary of Occupational Titles. ES202 employer lists were used by Field Center staff to survey employers. The results of the project were validated task lists made available to curriculum developers in both the Michigan labor and education environments.

A more important outcome of that work was the study of the Handbook of Occupational Keywords and how it related to the curriculum development process. The result was the development of the Michigan Occupational Data Analysis System (MODAS). The MODAS combined three databases: the V-TECS duty and task lists, the keywords in the HOOK Book, and the occupational characteristics information from the NOICC Master Crosswalks as derived from the DOT. Users of the system had several options:

- Duty and task lists could be retrieved from the system using a modified CIP code as an identifier.
- Tool and equipment lists could be retrieved from the system using the same modified CIP code identifier.
- Searches could be made using "and" and "or" logic to identify tasks related to keywords or combinations of keywords.
- Reports from the Vocational Preparation and Occupations could be customized to meet the needs of various audiences such as vocational rehabilitation, special populations, etc.

This was a significant event for vocational education and others involved in the design of training programs. While the HOOK Book had been designed to be used by job developers and counselors to match people to work using the keywords rather than using DOT codes, MODAS took this a step further so that tasks associated with the keywords could be identified, reviewed, edited, and configured for an individual's needs. A person could use the keywords to help write a skill resume or an employer could use the keywords to write a job description. It is important to remember that the system was driven by keywords and not job titles. Descriptions were at the task level, not at the keyword level. Data associated with DOT titles for which the tasks were developed could be retrieved and reviewed in the context of the new configuration and used as appropriate.

We believe that the new DOT/O*NET/SOC must rely on a taxonomy of terms to create descriptors and a computer based keyword concept to look at descriptors to identify common skills. This is the only way you can have a consistent language and deal with the transferability of skills across occupations. This is the only way you can create a skills-based system and maximize on its purpose.

An element by element, side-by-side review of the proposed Database of Occupational Titles has been presented in a two column format for ease of review and to insure a direct correlation for each point discussed (Figure 15, page 36). We realize that every potential DOT user would rate each element differently given their perspective or purpose in using the information. Ours is from the perspective of a vocational and technical education training perspective. After conducting this critique the authors were provided the model for the new O*NET which is shown below.

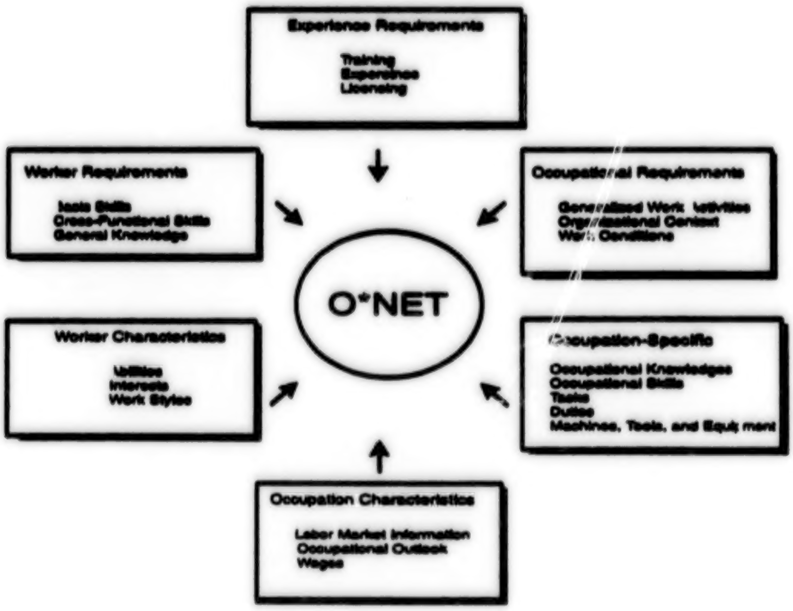
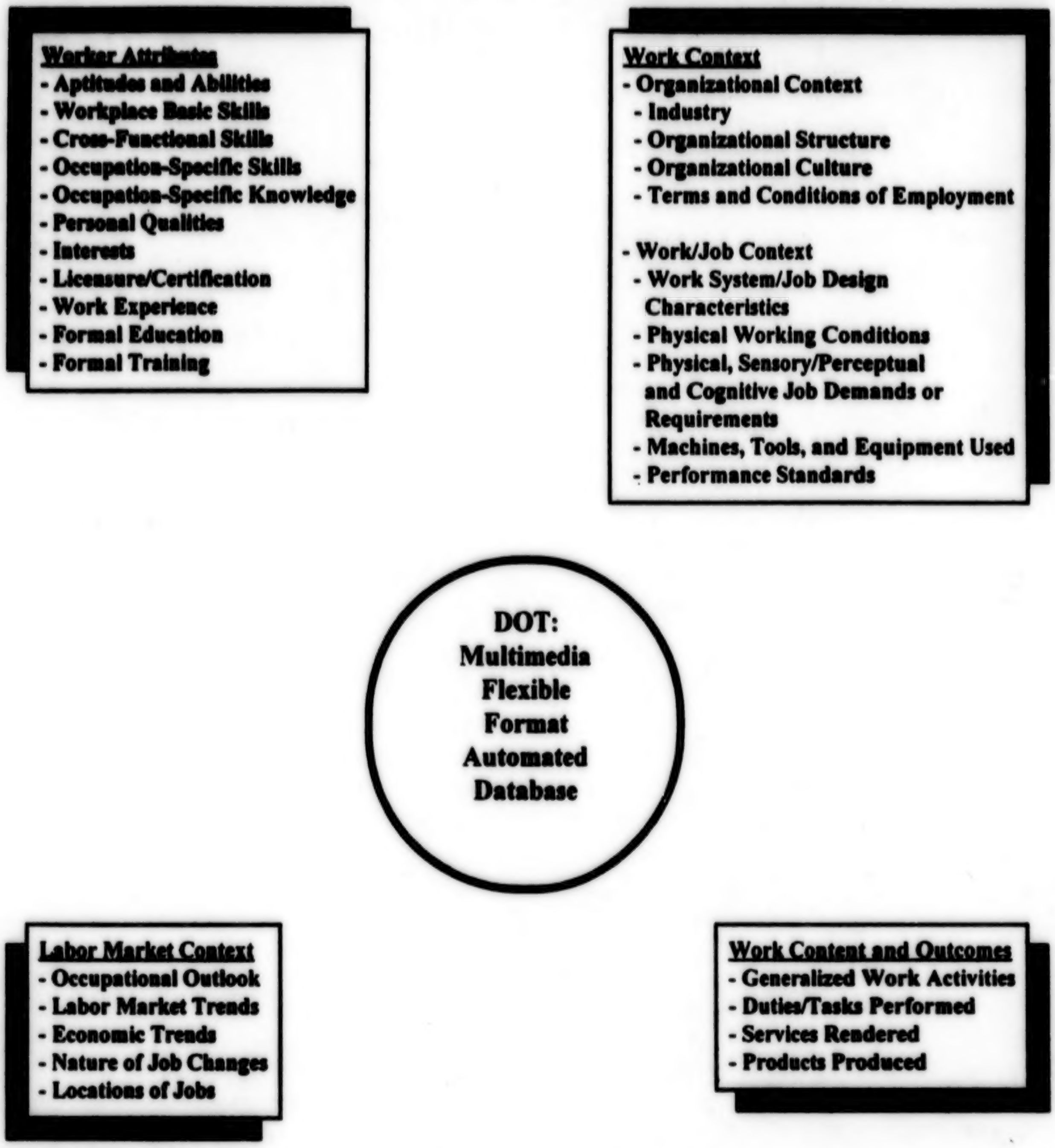


FIGURE 13
The New DOT Content Model



Worker Attributes
- Aptitudes and Abilities
- Workplace Basic Skills
- Cross-Functional Skills
- Occupation-Specific Skills
- Occupation-Specific Knowledge
- Personal Qualities
- Interests
- Licensure/Certification
- Work Experience
- Formal Education
- Formal Training

Work Context
- Organizational Context
  - Industry
  - Organizational Structure
  - Organizational Culture
  - Terms and Conditions of Employment

- Work/Job Context
  - Work System/Job Design Characteristics
  - Physical Working Conditions
  - Physical, Sensory/Perceptual and Cognitive Job Demands or Requirements
  - Machines, Tools, and Equipment Used
  - Performance Standards

DOT:
Multimedia
Flexible
Format
Automated
Database

Labor Market Context
- Occupational Outlook
- Labor Market Trends
- Economic Trends
- Nature of Job Changes
- Locations of Jobs

Work Content and Outcomes
- Generalized Work Activities
- Duties/Tasks Performed
- Services Rendered
- Products Produced

Source: United States Department of Labor; Employment and Training Administrative Advisory Panel on the Dictionary of Occupational Titles. The New Dot: A Database of Occupational Titles for the Twenty First Century. (Final Report) 1993, Washington, DC. Page 32.

FIGURE 14
The DOT Content Model

DOT CONTENT MODEL

· I. Worker Attributes

This section includes a series of descriptor categories related to the characteristics or qualifications that a worker brings to a job. The first five descriptors listed represent an approximate hierarchy or continuum of skills-related information (moving from general to increasingly specific levels of description and analysis) that is expected to provide a wide range of application options for users requiring skills information of different types and at different levels of specificity. It is expected that appropriate verification, elaboration and specification of these descriptor categories and their specific component elements will require further research.

DESCRIPTOR	CRITICALITY
Aptitudes and Abilities. The capacity to perform particular classes or categories of mental and physical functions; examples include: cognitive abilities (examples include: verbal, quantitative, abstract reasoning), spatial/perceptual abilities (examples include: spatial orientation and visualization, perceptual speed, flexibility and speed of closure), psychomotor abilities (examples include: arm, manual, and finger dexterity, eye-hand coordination), sensory abilities (examples include: vision, hearing, color discrimination) and physical abilities (examples include: static strength, dynamic strength, stamina, extent flexibility).	VERY IMPORTANT and should definitely be a part of the DOT. Selected data elements need to be more clearly defined. If things such as reasoning can't be better quantified than in the current DOT, just leave it out.
Workplace Basic Skills: Fundamental developed abilities that are required to at least some degree in virtually all jobs. Examples include: reading, writing and arithmetic or computational abilities. (These are included as a separate descriptor category because, although related to aptitudes and abilities, they include significant knowledge and learning components.)	VERY IMPORTANT. Things like reading, writing, arithmetic, need to be defined or quantified and made as contextual as possible. For example, write sentences is not near as descriptive as write sentences using technical terms.
Cross-Functional Skills. The various types of developed generic skills that are related to the performance of broad categories of work activity that tend to occur across relatively wide ranges of jobs. Examples include: information gathering, oral communication, problem analysis, negotiating, organizing and planning, coordinating with others and coaching or mentoring.	VERY IMPORTANT. Same comment as above. Descriptors need to be tied to functions. Problem analysis in one occupation is quite different than it is in another. In air conditioning, one person usually analyzes a failed component following a diagnostic process while in manufacturing problems may be solved by a team using a pre-determined problem solving process.

Occupation-Specific Knowledge. Understanding or awareness of, or familiarity with, the facts, principles, processes, methods, or techniques related to a particular subject area, discipline, trade, science, or art. Includes knowledge of foreign languages, computer programming languages and specific compute software packages or applications. Examples include: financial planning and analysis, fire protection systems, computer graphics, data communication networks, patent law, Spanish, COBOL, and spreadsheet software.	VERY IMPORTANT. Could be combined with or included in work content.
Personal Qualities. An individual's characteristic, habitual, or typical manner of thinking, feeling, behaving, or responding with respect to oneself, others, situations, or events. Examples include: self-esteem, sociability, responsibility and integrity/honesty.	MODERATELY IMPORTANT. This category could be included in workplace skills by using a set of slightly different descriptors.
Interests. Expressed affinity for performing particular types or categories or work tasks or activities, or applying particular types of skills. Examples include: realistic, investigative, artistic, social, enterprising and conventional.	MODERATELY IMPORTANT. Could be left out or incorporated into other descriptors that specify types of work. This is generally assumed to be part of analyzing one's background and should not necessarily be in this database since it is somewhat duplicated in other sections.
Licensure/Certification. The type of name of particular state licenses or professional or technical certification programs required for given jobs or possessed by an individual. Examples include: Board of Certified Safety Professionals (BCSP) certification; Certified Public Accountant (CPA); Registered Nurse licensure; American Production and Inventory Control Society (APICS) certification; and Academy of Certified Social Workers (ACSW) certification.	IMPORTANT now. Will become even more important as time goes on as more and more systems are in place to certify workers.
Work Experience. The type and amount of either paid job experience (acquired in regular full- or part-time employment, military jobs, paid apprenticeship, internship, or trainee positions) or unpaid job experience (acquired in volunteer or civic activities or in student work-study programs) required or characteristic of workers in a given job or possessed by an individual.	IMPORTANT but should be kept very brief and concise. Could be combined with licensure/certification information since these tend to require work experience as a part of the qualification criteria.
Formal Education. The type and amount of secondary school, vocational-technical school, college, or university education required or characteristic of workers in a given job or possessed by an individual.	IMPORTANT. Often closely related to licensure/certification and work experience.
Formal Training. The type and amount of learning or instruction, acquired through such means as apprenticeships, certification programs, military training programs, practicums and organization- or association-sponsored training programs (but outside of formal academic or educational settings) required or characteristic of workers in a given job or possessed by an individual.	Should have one category for formal education and training. As we move toward a skills environment, the distinction between degrees and certificates will tend to merge.

II. Work Context

This section includes descriptors for Organizational Context and Work/Job Context. Organizational context includes descriptors related primarily to the broader organizational system within which work is carried out. Work/Job Context includes descriptors related to the more immediate job context.

It should be noted that some of the descriptor categories and component elements listed in this section (more so than in other sections) are prone to vary as a function of the specific setting, location or type of organization in which a job is performed, and hence may not represent generalizable characteristics of a job or its context. APDOT's view is that this determination should be based on empirical job analysis. Such data can then be used to determine the most appropriate manner of treating such characteristics in a DOT occupational description.

ORGANIZATIONAL CONTEXT

Industry. The major or defining activity or purpose of the establishments in which a given job is performed, such as defined in the Standard Industrial Classification (SIC) system. Examples from the current SIC include: Retail Trade, Finance, Insurance, Real Estate, and Health Services.	Use the Industry/Occupation Crosswalk Matrix to crosswalk occupations into industries.
Organizational Structure. Includes such elements as: • size of organization (examples include: number of employees, divisions, work units) • type of organization (examples include: non-profit, conglomerate, multinational) • degree of product or service diversity or specialization • mode of organizational structure and production control (examples include: hierarchial versus flat, centralized versus decentralized) • Reward structure (examples include: bases for wage and salary treatment, bases for performance and promotion evaluation)	VERY IMPORTANT. In some ways this category indirectly infers those things that tell people whether their interest match the place of employment.
Organizational Culture. Includes such elements as: • operating values/style (examples include: institutional fairness, employee involvement, open communication, customer focus, continuous learning environment, entrepreneurial, diversity, social responsibility) • strategic emphases (examples include: quality, speed of production, innovation, low cost, automation/technology infusion)	SAME COMMENT AS ABOVE. This again tells me whether I would be interested in an occupation based on my interest.
Terms and Conditions of Employment. Includes such elements as: • work schedule (examples include: hourly, shift work, daily) • type of compensation (examples include: salary, wages, fee-for-service, incentive or commission) • amount of compensation (examples include: ranges) • travel or relocation requirements • degree to which work is unionized • special clothing or uniform requirements	VERY IMPORTANT. However, the wages category will require a significant amount of upkeep.

WORK/JOB CONTENT	
Work System/Job Design Characteristics. The characteristic manner in which a given job is designed and work is organized, especially in relationship to other aspects of the organizational system of which the job is a part. (Note: The combination of many of these elements may be used to define what has come to be called a "high performance" workplace or organization, and hence may help to determine the degree to which it is appropriate to characterize a given organization or work setting in this manner.) Examples of such elements include: • degree of shared or interdependent task or job responsibility (examples include: team vs. individual organization of work) • degree and nature of interactions with technology • decision making and/or dollar accountability (examples include: degree of empowerment, autonomy or latitude for judgment) • degree to which job entails performance of a variety of tasks or use of a variety of skills • degree of task or job identify • skill or knowledge acquisition or maintenance demands (examples include: degree to which frequent or continuous learning is required) • nature of job impact (examples include: remote, indirect, contributory, shared, direct) • degree of job impact (examples include: sphere of influence, number of people affected) • degree of structure (examples include: presence of formal guidelines, policies or standard procedures) • pace or intensity of work • degree and duration of contact with others • scope and nature of communications or interactions with others • degree of stability or dynamism in work schedules, methods and procedures or job duties and responsibilities • degree and type of performance feedback available	VERY IMPORTANT. But tends to replicate some of the sub-descriptors shown under the other major descriptors in this category.
Physical Working Conditions. The nature of the immediate physical environment in which a job is performed. Includes such elements as: • the nature or type of work setting (examples include: indoor/outdoor) • type of work location (examples include: factory, office) • physical hazards present (examples include: chemicals, radiation, combustibles, etc.) • physical discomforts present (examples include: noise, vibration, odors, dust, fumes, etc.)	SAME COMMENT AS ABOVE.

Physical, Sensory/Perceptual and Cognitive Job Demands or Requirements. An occupation's characteristic type and degree of physical (examples include: standing, carrying, lifting, climbing, stooping), sensory/perceptual (examples include: color or auditory discrimination, depth perception) and cognitive (examples include: vigilance or information encoding, processing and retrieval) job demands.	VERY IMPORTANT to guidance counselors since you can't legally tell a disabled person they can't do a certain task or job but you can advise them that if they go into a given occupation they will have to lift objects weighing 150 lbs, or climb a ladder, which leaves the decision regarding degree of disability to the individual based on how they perceive themselves.
Machines, Tools and Equipment Used. Physical instruments or devices used to carry out or facilitate the completion of particular jobs, work activities or tasks. Examples include: printing press, electric hoist, bulldozer, milling machine, pneumatic hammer, tape measure, camera, photocopying machine, facsimile machine, laptop computer, radio transmitter and vide recorder.	VERY IMPORTANT.
Performance Standards. The nature of the production or quality criteria by which the work performed in a given job is typically judges or evaluated. Examples include: amount produced, quantity sold, error or defect rates and timeliness of production or service.	VERY IMPORTANT but is already reflected in other sections. Could also be tied to Products Produced by Adding to What Standard.

III. Work Content and Outcomes

This section includes a series of descriptor categories related to the content of the work actually carried out by an individual and the outcomes resulting from this work.

Generalized Work Activities. Aggregations of related duties or tasks into somewhat more general activity statements that do not include highly job-specific content. Examples include: writing technical reports, reading blueprints, preparing budgets and repairing electrical appliance.	IMPORTANT. Somewhat duplicative of what we define as cross-functional skills. Some of these can also be duties or task performed, given the context of discussion.
Duties/Tasks Performed. The specific work steps, elements, or activities performed in order to achieve a given work objective. Examples include: locate and repair leaks in pressurized cable, prepare written replies to customer inquiries or complaints and type and proofread statistical reports.	VERY IMPORTANT. If this section is developed properly, it will reveal a lot about basic skills, workplace skills, etc.
Services Rendered. The services provided by an individual or organization based on the work that individuals or work teams perform. Examples include: guidance and counseling, cleaning, teaching and medical testing.	REDUNDANT
Products Produced. The products designed, developed, made, or manufactured by an individual or organization based on the work that individuals or work teams complete. Examples include: automobile parts, compact discs and food products.	REDUNDANT. Section III Work Content and Outcomes could be combined with Section I and eliminate a lot of redundancy.

IV. Labor Market Context

This section includes a series of descriptor categories related to the boarder economic and labor market setting in which jobs are performed, as well as information regarding how these factors affect given jobs. It is expected that the information comprising this category will not be obtained from the job analysis process used to gather data on individual jobs, but rather from linkages with other databases and information sources such as those developed by the U.S. Office of Personnel Management (OPM), Bureau of Labor Statistics (BLS), and the U.S. Department of Education.

Occupational Outlook. Information related to the future of the occupation, describing potential educational and occupational requirements and employment prospects. Examples include: BLS information on occupational outlook and OPM projections for future employment.	IMPORTANT
Labor Market Trends. Information related to current and future employment in specific occupations. Examples include: total employment for specific occupations.	IMPORTANT
Economic Trends. INFORMATION related to economic patterns that have implications for employment. Examples include: growth patterns by industry and/or occupation.	IMPORTANT
Nature of Job Changes. Information related to changes in occupations. Examples include: changes in employment, occupational requirements and industry.	Couldn't this be a part of the occupational outlook?
Locations of Jobs. Information related to location of occupations geographically or within the organization. Examples include: total employment of specific occupations by geographic area, organizational unit where occupation may be located such as printing department, audio visual department.	Could be covered in Section II under industry, or organizational structures.

NOICC MASTER CROSSWALKS

The NOICC Master Crosswalk is a computerized database that shows relationships among the five major occupational and educational classification systems used by the Federal government. The Crosswalk begins with the Dictionary of Occupational Titles (DOT), which is the common denominator used to link all Federal classification systems. Through the Master Crosswalk, data classified according to each of the Federal classification systems can be related to data classified according to one or all of the other systems. The National Crosswalk Service Center (NCSC) is a technical resource center of the National Occupational Information Coordinating Committee (NOICC) and State Occupational Information Coordinating Committees (SOICs). NCSC maintains the NOICC Master Crosswalk and provides a range of products and services based on the Crosswalk and other Federal occupational and labor market information resources. NCSC is operated by the Iowa SOICC under a grant from NOICC.

In cooperation with NOICC and other Federal agencies, the National Crosswalk Service Center manages and updates the Master Crosswalk; provides technical assistance in its use; and answers requests for data and information. NCSC also services as a depository of computerized occupational and educational information resources, including:

- NOICC Master Crosswalks
- Bureau of Labor Statistics (BLS) Crosswalks
- BLS National Industry/Occupation Projections Matrix
- Dictionary of Occupational Titles (DOT) Manual
- Standard Occupational Classification (SOC) Manual
- Classification of Instructional Programs (CIP) Manual
- Standard Industrial Classification (SIC)
- Occupational Employment Statistics (OES) Survey Dictionaries
- Standard Occupational Classification (SOC) Career Profiles
- Occupational Outlook Handbook
- Military Occupational and Training Data
- States depend very heavily on NOICC's and SOICC's; consequently, they need to be directly involved in this effort

PROTOTYPE SKILLS-BASED JOB FAMILY MATRIX

The new Prototype Skills-Based Job Family Matrix classification system groups different Occupational Employment Statistics (OES) occupations into skills-based job families, based on similarities in distinguishing work activity and level of preparation. By grouping narrow occupations into broader job families, this new structure is intended to expand the perspective of individuals searching for a job by encouraging them to look beyond their narrow occupation and industry to help them identify other jobs for which they may have transferable skills.

The prototype skills-based job family matrix reflects an effort to meet the current needs and demands of users of occupational data to focus on the skills components of jobs. The grouping of specific occupations with similar occupations, into broader job families, also reflects workplace changes occurring over the past two decades -- the broadening of job responsibilities and the blurring of demarcations between jobs.

Occupations are distributed within cells of the skills-based job family matrix, based on the associated level of required education, training or experience (vertical axis) and on the general field of training or work activity (horizontal axis). The matrix is organized by four "preparation levels" (plus one separate category for managers) and fourteen "distinguishing activity areas" or fields of work. There are 54 major matrix cells that contain employment, based on the OES survey.

Job Families

Each of the matrix cells is comprised of multiple, more specific job family groupings. Job families are groupings of one or more OES occupations with a similar level and field of prerequisite training or work experience, and within which a degree of occupational mobility is assumed. Some minimal retraining as well as on-the-job training may be required for individuals to effectively transition into a new job; however, occupations that require substantial specific preparation for entry into employment, such as engineering specialties, are maintained as separate job family groups. A total of 328 specific skills-based job families have been distinguished.

Preparation Levels

Five distinct preparation levels are defined according to the levels of education, training, or specific experience for entry into employment. These preparation levels, denoted on the vertical axis of the job family matrix, are very similar to the Canadian National Occupational Classification (NOC) "skill levels," and are listed below:

Level 0 --	This level covers mangers which normally requires a university education or substantial equivalent work experience.
Level 1 --	Four-year postsecondary or graduate degree is required.
Level 2 --	Two or three years of postsecondary education or training through a community college or technical institute; two to four years of apprenticeship training; or two to three years of specific work experience, on-the-job training, or training courses.
Level 3 --	High school degree preferred, as well as up to two years of on-the-job training, specific work experience, or training courses.
Level 4 --	High school degree not required; short work demonstration or on-the-job training.

The broad preparation level categories reflect general routes of entry for employment. These categories describe the average general education and training requirements for component OES occupations, rather than the range of individuals employed in these occupations.

Distinguishing Activity Areas

Distinguishing activity areas denote fields of work, knowledge, or preparation. The U.S. prototype matrix diverges further form the Canadian NOC system in delineating these groupings for two major reasons. First, some of the NOC cells (of which there are nine) seemed to be too broad. Second, some of the Canadian "skill types" are strongly reflective of internal labor markets within industries and firms. *To the extent possible, the distinguishing activities in the U.S. prototype matrix were formed in an effort to first reflect occupational skills that are transferable across industries, and then to categorize the remaining occupations that are unique to particular industries.*

The prototype skills-based job family matrix is comprised of the following fourteen distinguishing activity areas:

- Administrative, business, and financial occupations
- Natural and applied science occupations
- Health occupations
- Law, social science, and social and community service occupations
- Education, training, and instructional occupations
- Art, culture, and recreation occupations
- Sales and promotion occupations
- Protective service occupations
- Personal and commercial service occupations
- Construction and extractive occupations
- Transportation and material moving equipment operation occupations
- Agriculture and forestry occupations
- Mechanics, repairers, and precision craft occupations
- Manufacturing, processing, and plant and systems operations occupations

Source: Department of Labor: Prototype Skills-Based Job Family Matrix

The complete prototype is shown on the next page.

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Figure 15
PROTOTYPE SKILLS-BASED, JOB FAMILY MATRIX

Distinguishing Activity Preparation Level	02 ADMINISTRATIVE BUSINESS, & FINANCIAL OCCS	05 NATURAL & APPLIED SCIENCE OCCS	06 HEALTH SERVICE OCCS	07 LAW, SOCIAL SCIENCE & COMMUNITY SERVICE OCCS	09 EDUCATION & TRAINING OCCS	10 ART CULTURE & RECREATION OCCS	12 SALES & PROMOTION OCCS	14 PROTECTIVE SERVICE OCCS	15 PERSONAL & COMMERCIAL SERVICE OCCS	17 CONSTRUCTION & EXTRACTIVE OPERATIONS OCCS	18 TRANSP. & MATERIAL MOVING EQUIPMENT OPERATIONS OCCS	19 AG & FORESTRY OCCS	20 MECH REPAIR & PRECISION CRAFT OCCS	21 MFG PROCESS & PLANT & SYS OPERATION OCCS
	020 General, Administrative, Business & Financial Managers	050 Engineering & Natural Science Managers	060 Medicine & Health Service Managers	070 Public Administrators, Chief Executives, & Legislators	090 Education Administrators		120 Marketing, Advertising, & Sales Managers		150 Personal & Commercial Service Managers	170 Construction & Extractive Operations Managers		190 Agriculture & Forestry Managers		210 Industrial Production Managers
	021 Professional Administrative Business & Financial Occupations	051 Professional Natural & Applied Science Occupations	061 Professional Health Service Occupations	071 Professional Law, Social Science & Community Service Occupations	091 Professional Education & Training Occupations	101 Professional Art, Culture & Recreation Occupations	121 Professional Sales & Promotion Occupations	141 Professional Protective Service Occupations		171 Professional Construction & Extractive Operations Occupations	181 Professional Transportation Occupations			
	022 Skilled Administrative Business & Financial Occupations	052 Technical Natural & Applied Science Occupations	062 Technical & Skilled Health Service Occupations	072 Skilled Law, Social Science & Community Service Occupations	092 Skilled Education & Training Occupations	102 Skilled Art, Culture & Recreation Occupations	122 Skilled Sales & Buying Occupations	142 Skilled Protective Service Occupations	152 Skilled Personal & Commercial Service Occupations	172 Skilled Construction & Extractive Operations Occupations	182 Skilled Transp. & Mat. Moving Equipment Operations Occupations	192 Skilled Agriculture & Forestry Occupations	202 Skilled Mechanics, Repairers, & Precision Craft Occupations	212 Skilled Mfg. Machine, Plant, & Systems Operators
	023 Clerical & Administrative Support Occupations		063 Health Service Assisting Occupations		093 Education & Training Assisting Occupations	103 Intermediate Art, Culture & Recreation Occupations	123 Intermediate Sales Occupations	143 Intermediate Protective Service Occupations	153 Intermediate Personal & Commercial Service Occupations	173 Intermediate Construction & Extractive Operations Occupations	183 Intermediate Transp. &Mat. Moving Equipment Operations Occupations	193 Intermediate Agriculture & Forestry Occupations	203 Intermediate Mechanics, Repairers, & Precision Craft Occupations	213 Intermediate Mfg. Machine, Plant, & Systems Operations
4							124 Elemental Sales Occupations	144 Elemental Protective Service Occupations	154 Elemental Personal & Commercial Service Occupations	174 Elemental Construction & Extractive Operations Occupations	184 Elemental Transp. & Mat. Moving Equipment Operations Occupations	194 Elemental Agriculture & Forestry Occupations	204 Elemental Mechanic & Repairer Occupations	214 Elemental Mfg., Plant, & Systems Operations Occupations

Updated 3/94 This prototype draws upon work done in Canada referring to the development of their 1992 National Occupational Classification (NOC). Preparation levels are defined as requiring the following level of education and/or training.

Level 0 - Management education, training, or experience
Level 1 - Four years postsecondary or graduate degree
Level 2 - Two or three years of postsecondary education, training or specific experience; or two to four years apprenticeship.
Level 3 - High school degree preferred; up to two years on the job training; specific work experience, or training countries.
Level 4 - High school degree not required: short work demonstration, or on the job training.

Source: U. S. Department of Labor

NOICC PROTOTYPE UNITS OF ANALYSIS

While writing this paper, we were provided with the NOICC Prototype Units of Analysis. We have included excerpts of it here because we feel it best illustrates how the vocational and technical education and training community uses Labor Market Information to make decisions about which school-to-work programs to develop and what occupational titles might be addressed for a specific occupational cluster. The NOICC Units of Analysis crosswalks the five digit OES codes and titles used for gathering labor market information with the six-digit code or program titles of the Classification of Instructional Programs (CIP). The actual data being displayed are those employed, those needed for employment, and the growth or demand as compared to those trained or available for the workplace by educational levels (see Figure 16, page 47).

These data could be made even better given a revised Standard Occupational Classification System since different occupational clusters play out differently. For instance, we have selected three different clusters to illustrate the interpolation that has to be done now. Looking at Cluster 2260: Computer Systems, we see three different occupational titles being supplied by some twelve different program titles. For Cluster 2711: Tool and Die Making, we see a one-to-one-to-one match. For Cluster 2720: Metal Fabrication, we see one program title providing potential workers for eleven different occupational titles. This is not to argue that we should always have or will ever have a one-to-one match between work and preparation for work. However, it does illustrate the problems involved in trying to provide meaningful training programs based on current ways of collecting and reporting data. It also illustrates the excellent work being done by NOICC to solve the problems for the field that often goes unnoticed by many policymakers.

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FIGURE 16
Extracts rom NOICC Prototype Units of Analysis

		1992	2005	JOB OPENINGS			LESS THAN				FIRST	
OCCUPATION(*=ALLOC.)/PROGRAM (*=PART)		EMPL	EMPL	GROWTH	REPL.	TOTAL	BA/BS	BA/BS	MA/MS	PH.D	PROF	TOTAL
CLUSTER: 2260 COMPUTER SYSTEMS												
DEMAND:												
25102	Systems Analysts and Computer Scientists	455,106	956,127	38,540	3,002	41,542						
25104	Computer Programmers	554,658	723,452	12,984	13,194	26,178						
25111	Programmers, Numerical Tool & Process Cont	7,202	7,784	45	136	181						
SUPPLY:												
11.0101	Computer & Information Sciences, General						5,371	16,070	7,022	667	0	29,130
11.0201	Computer Programming						7,643	445	71	0	0	8,159
11.0301	Data Processing Technology/Technician						5,461	288	76	0	0	5,825
11.0401	Information Sciences & Systems						1,853	3,634	1,214	22	0	6,723
11.0501	Computer Systems Analysis						126	279	73	6	0	484
11.0701	Computer Science						757	3,400	744	73	0	4,974
11.9999	Computer and Information Sciences, Other						5,992	839	399	7	0	7,237
52.1201	Mgt Info Systems & Business Data Processing						7,866	4,702	1,451	8	0	14,027
52.1202	Business Computer Programming/Programmer						5,012	30	0	0	0	5,042
52,1203	Business Systems Analysis and Design						285	72	0	0	0	357
52.1204	Business Systems Networking and Telecommuni						303	104	125	0	0	532
52.1299	Business Information & Data Processing Service						3,306	116	0	0	0	3,422
CLUSTER: 2711 TOOL AND DIE MAKING												
DEMAND:												
89102	Tool and Die Makers	137,564	128,204	0	3,691	3,691						
SUPPLY:												
48.0507	Tool and Die Maker/Technologies						615	1	0	0	0	616
CLUSTER: 2720 METAL FABRICATION												
DEMAND:												
*83000	Inspectors, Testers & Graders, Precision	35,386	26,320	0	790	790						
*87823	Sheet Metal Workers and Duct Installers	142,299	159,163	1,297	3,658	4,955						
*89198	All Other Precision Metal Workers	16,503	15,443	0	347	347						
91302	Punching Machine Setter & Set-Up Ops, Metal	45,093	37,604	0	964	964						
91321	Machine Forming Operators & Tenders, Metal/P	155,153	122,888	0	4,195	4,195						
*91399	All Other Machine Tool Cutters and Formers	51,362	45,615	0	1,103	1,103						
91714	Metal Fabricators, Structural Metal Products	45,057	45,249	15	807	822						
*92100	All Other Metal/Plastic Machine Setters/Ops	17,616	16,583	0	473	473						
93108	Fitters, Structural Metal, Precision	14,691	14,484	0	307	307						
*93196	All Other Precision Assemblers	4,643	4,727	6	99	105						
*93997	All Other Assemblers and Fabricators	103,589	82,413	0	1,740	1,740						
SUPPLY:												
48.0506	Sheet Metal Worker						1,447	0	0	0	0	1,447

CONCLUSIONS/RECOMMENDATIONS

The authors of this paper represent one aspect of the "supply side" of the labor market information community. In preparing for the task of writing this paper, they dutifully reviewed the literature that was made available to them. (See References). While the literature was very helpful for developing an understanding of the intricacies of the classification systems, most of the articles in the Proceedings document were written from the "demand side" perspective as to origin, development, purpose, and use of occupational information. Consequently, we have attempted to address the needs of the supply side in this paper. The authors strongly recommend that those working on the new SOC read the many papers written on this topic. In this context they have highlighted those listed in the references that are the most relevant.

The authors' purpose in presenting the Indiana Scenario as well as for providing the occupational skills cluster discussion was to present some of the needs of those who educate and train individuals for the workforce. The Indiana Scenario is a "real-time" situation and the issue of developing clusters is a real-life issue. In their daily work, the authors hear the ever increasing argument that the purpose of all education and training is to prepare people in the broader context so they will carry maximum flexibility to the workforce but the facts are that program completers and graduates will need work to fill positions because of the "fit" they bring to the workplace and that also requires specialized preparation for their career choice.

In a recent address to the American Vocational Association Annual Legislative Seminar, the U.S. Secretary of Labor, Robert Reich made the observation that we have approximately the same number of people looking for work that we have jobs available that can't be filled because of the mismatch between the skills these individuals have and the skills needed in the jobs that are going vacant. In this context it is ironic that on no less than three occasions in three different cities during the last three months we have been served lunch or dinner by individuals who openly stated they had just received degrees in English and were back in school pursuing a graduate degree or enrolled in a technical program in a community college or technical institute because there were no jobs for English majors other than in the field of teaching and working as a wait person paid more than teaching. Furthermore, it is relatively common knowledge in the education and training community nearly 30% of the students currently enrolled in postsecondary technical institutes or community colleges for at least the last five years already hold generic brand degrees in fields that have no employment potential.

Likewise, the authors have heard the arguments that there are many jobs, especially at the entry level or in a particular business or industry for which there are no directly related education and training programs. However, this does not negate the need for an accurate description of what the job entails. Training programs to supply the workforce were, perhaps, the first to use occupational analysis to better the fit between job applicant and the job. However, in today's world where Total Quality Management is the key, occupational analysis for jobs is critical to the quality process and this analysis is not unlike that used for training and, in fact, is increasingly being used by the employer to train workers, in-house, for those jobs. Occupational and task analysis is nothing more than process analysis which is the backbone of analyzing problems in most TQM models.

The authors contend that those individuals who work on the supply side as well as those wanting to enter the workforce regardless of the employment level should know the job opportunities that are available and what they must do to qualify for them. Just as the person studying to be an Engineering Technician, or a Heating, Ventilation, and Air Conditioning Technician should know what they must be able to do to be employed, the "English" major should also know what they must do to be employed. The importance of systematic and consistent occupational analysis does not increase nor diminish with the nature of the job or the preparation required of the job.

As the need for sound labor market information has become more critical to those on the supply side, it has placed those who help supply the talent for the labor market into the role of a customer for the services of those on the demand side. Conversely, as educational programs do more to improve the supply side, those on the demand side became "customer" for these services.

The originators of the original California Crosswalk and the Vocational Preparation and Occupations recognized a need for the customers on both sides to be able to communicate with their suppliers. The current NOICC Master Crosswalk continues this tradition and provides a very useful service, especially from the authors' point of view, to enable workforce entrants/participants striving to become employed, reemployed or more productive ("Future use of the SOC," Drayse et. al., p.52, Proceedings of the International Occupational Classification Conference, USDOL-BLS, September 1993, Report 833) to achieve their goals. A revised SOC that collapsed the other major classification systems into it would make it much easier for NOICC to perform these functions.

V-TECS has had to address the customer/supplier issue in the delivery of products and services. In this endeavor, it has become important to the organization to adopt a Total Quality Management model. The Indiana Scenario, likewise, describes protocols to develop proficiencies and to permit assessments that meet their customer's needs, which, in Indiana's case, is clearly the employer. Protocols such as those used in TQM by V-TECS and Indiana require a process to be clearly identified, the development of control characteristics to permit monitoring to ensure the process is being completed in compliance with the protocol. If it isn't, provision is made for corrective action and continuous improvement.

FIGURE 17
Indiana Essential Skills and Technical Proficiencies
TQM Process Control Plan
Indiana Assessment Development and Administration Protocols

Process	Process Control	Key Characteristics or Benchmarks	Root-Cause Analysis	Corrective Action	Continuous Improvement
Process includes the tasks to develop and administer assessments to report technical proficiency and to award Certificates of Technical Achievement.	Process Control includes the steps to achieve the process.	Key Characteristics or Benchmarks are the observable evidence that will be accepted as proof that the process has been followed.	After the process has been completed and evaluated, Root-Cause Analysis can be used to examine those elements that have not met the Key Characteristics or Benchmarks.	Corrective Action is the plan to achieve the Benchmarks as required of the process based upon the results of root-cause analysis.	Continuous Improvement includes any changes to Process, Process Control, or the Key Characteristics/ Benchmarks determined necessary through Root-Cause Analysis.

Germane to this discussion, is the protocol that V-TECS uses, (The V-TECS Technical Reference Handbook for Product Development) for performing occupational analysis to define occupations (reports of the duties, tasks, tools and equipment, steps, and standard for the domain or occupational titles) and other V-TECS products. The protocol for conducting occupational analysis is rooted in the Dictionary of Occupational Titles for identification of the jobs being analyzed or studied. The original protocol was adapted from the U.S. Air Force Industrial System (ISD) Design Model and has been applied equally to all occupations whether they be in the service or manufacturing sectors. The protocol allows for several DOT or occupational titles to be treated in one occupational cluster. For example, the Machine Tool Operations catalog reports as duties the various machines and as tasks, the procedure for operating those machines. Developers of the Machine Tool Operations catalog had to make a decision whether or not to comply with the protocol as there are more than five machines in most shops and the DOT treats each machine as a separate job description sometimes expanding this to develop separate descriptions for "helper" or "apprentice." The authors' experience in this industry, however, shows "entry" level workers begin mastering one machine and pay and promotion reflects the number of machines they can master and operate. The first machine they learn can vary from employer to employer. The process is constant, however, in that they begin on one machine, master other machines, and become a master machinist or supervisor when they have mastered all the machines in a given work environment.

The V-TECS data elements accurately reflect this reality by identifying tasks required to operate all machines and includes the core tasks in areas such as benchwork and using measurement instruments. Even following the protocol limit of five DOTs, the final product was still able to be an accurate reflection of real-time practices in industry.

By contrast, in the service sector, the conditions of employment are different but the protocol for analysis is the same. In the health field, there is an occupational analysis for "Nursing Assistant" which is also a DOT title (Nurse Assistant). It treats that occupation the same as the Machine Tool Operations catalog treats the occupation of "machinist." The amount of content varies in each catalog.

Indiana added the SCANS architecture to the V-TECS occupational analysis process. Had the SCANS technology been available and applied ala Indiana when the Machine Tool Operations and the Nursing Assistant catalogs were originally developed by V-TECS' member states, there would be duties and tasks that would legitimately fall into the broad SCANS categories of Resources, Information, Interpersonal Skills, Systems and Technology. SCANS has permitted the transferability of skill at some level of specificity and has provided the means by which workers can pursue career ladders which, increasingly apparent in today's world, are probably with a different employer.

The authors offer the following as conclusions based on our observations:

1. An occupational analysis protocol should be developed that allows for the continual flow of new and fresh information into the new DOT/O*NET model. If a consistent protocol was developed, such as the one currently being used in the Indiana Proficiency Panel Initiative and with the Indiana Workforce Development Centers, an information exchange could be arranged to permit the database to be fed from a variety of sources outside of the typical governmental agency units. Such a protocol would have to follow precepts of Total Quality Management in order for the exchanged data to have validity and reliability.

2. A common language should be adopted for the collection of data that is to be used to define the occupational titles included in the database. The authors recommend a combination of a duty/task or work activities approach along with a description of the skills which can be organized using the SCANS competency framework. This would be supplemented with data sets drawn from the O*NET which would be applied equally to those performing analysis to identify jobs on the demand side and to those developing training on the supply side. The SOC and DOT/O*NET should have a format for reporting out this information that follows the key concepts contained in the CIP.

3. A consistent occupational structure should be developed to maintain the integrity of the customer/supplier relationship between the various agencies that collect, report, and use labor market data. This structure can be modeled after existing structures but should be hierarchical as follows:

Numbering	Name of Occupational Field	Example
00.	Family/Industry	Creative Arts
00.00	Cluster/Programs	Architecture Cluster
00.0000	Specialties/Clusters/Skills	Landscape Architecture
00.000000	Job Titles	Landscape Architect

Examples taken from NOICC Units of Analysis

It is critical from the supply side of the equation that if we, as the customer of the demand side, are to be able to be effective in our role, we need to have as close a match as possible at the occupational level. Even when considering the argument that education should be broader based and permit flexibility on the part of the student, school-to-work providers must be able to draw curricular, counseling, and placement conclusions at the occupational title or cluster level.

It is also critical from the supply side that as we respond to the Total Quality Management models currently used in business and industry (including the manufacturing and service sector) that the process be consistent, the classification scheme be consistent, and the collection and reporting procedures be consistent, to maximize the value of the information on both sides of the supply/demand equation.

Conclusions

The authors originally felt a duty to array their conclusions against the 12 Principles of Classification as reported in "The 1980 Standard Occupational Classification" by MacDonald, et. al., p. 16. (Proceedings of the International Occupational Classification Conference, USDOL, BLS, September 1993, Report 833) The article reports that "These principles were the result of trying to accommodate the diverse needs of the occupational information user community." It is not our intent to criticize the 1980 SOC but a reader of the article will find little or no discussion relating to the needs of the supply side as represented by discussion of the Office of Education coding structures used in education and training. Besides, our expertise is not in classification principles but, rather, in how the information is used on the supply side, primarily in the vocational-technical education community.

Rather than address the Principles of Classification, the authors have used the questions at the beginning of this paper as a framework and presenting our conclusions which are based upon our research and supply-side experience in both the vocational-technical education community as well as having worked with business and industry to determine what people do and what skills they need to do it.

Structure Questions:

1. What do the existing classification systems have to offer this endeavor?

The authors feel that the existing classification systems can make a substantial contribution to this initiative to revise the SOC. People who use and report labor market information from both the supply and demand sides have gained valuable experience and insights into what the future system should include and how it should be structured. It would be folly to ignore this and begin to develop a revised system from scratch. However, conditions have changed. We are moving towards total quality management systems, a workforce that needs to be empowered to be employed, reemployed and to be more productive. This means that the revised system needs to be responsive to a variety of agencies and organizations who work in this area in order to capture information that is current and fresh.

2. What should be the relationship between the occupational clusters and the occupational analysis system(s) and data collection system(s) that will redefine the new Database of Occupational Titles (O*NET), Standard Occupational Classification System, and the National Skill Standards Board?

The authors contend that a system can be designed that, using a hierarchy from general to specific perhaps with four levels (but not necessarily limited to four levels) will account for current and future occupational structures and will provide satisfactory information for customers of the data. We feel that the Prototype Matrix is one such framework but also feel the twenty headers now used in the SOC are probably as defendable as the fourteen used in the Prototype.

It may be that there will need to be some bureaucratic fence mending or even fence removal to achieve this goal. As business and industry have moved away from the traditional Taylor model of organization to one in which the workforce is empowered, the authors suggest that the agencies and organizations that collect, report, and use labor market information adopt a more empowered model, strive to remove the barriers, and encourage the flow of information in a flatter environment and with more lateral movement.

3. How many occupational clusters will ensure coverage of the world of work?

The answer to this questions is not easy. The authors have discussed the various clustering models and the variance in the total number of clusters. The authors recommend that a scheme such as the Prototype Skills-Based Job Family Matrix or the work that NOICC is doing on the "superclusters" and "units of analysis" be carefully reviewed in the spirit of the discussion in question #2 above. The authors feel that much of the discussion on the number of clusters is driven by "turf issues" and should be resolved in a more collegial and scientific manner by those agencies involved.

4. Should the SOC occupational clusters be developed using a supply/demand (economic) base or a skills/work activity approach?

The authors would like to cite the Drayse, et. al., article on the "Future Use of the SOC" in the Proceedings of the International Classification Conference (USDOL, BLS, September 1993, Report 833, p.48) because it expresses very well our feelings about this questions:

> A primary test of the usefulness of occupational information is its power to provide a plausible, grounded account of the actual experience of workers. Just as a job should connect an individual's activities with a larger group of workers and their activities, and that in turn with the output of a product or service that is valued by a changing society, a useful description of that job should reflect significant characteristics of the worker, the activity, linked activities of other workers, and processes of change. Since the labor market is not in equilibrium, descriptions of constant and established factors offer good but only partial insight; in effect, a snapshot in time. The dynamic relationships among occupations, and between occupations and changes in demographics, production processes and markets, make it necessary to continuously incorporate fresh information into occupational classification systems.

The authors strongly encourage a "work activity and skills combination" approach. It is the authors' experience that this approach works best when developing curriculum and training programs, assessing the skills of the workforce, developing employer based training programs, and providing counseling and placement services to those entering employment, seeking reemployment or trying to become more productive in ways such as advancing along a career ladder.

This does not negate the importance of some of the economic issues. For example, enrollments in vocational-technical education training programs are an indicator of the economic condition of the community or other geographical region. However, enrollment data does not help with developing curriculum for the customer of vocational-technical education training programs or from the employer. The authors feel that a consistent and systematic process to identify and report the activities of the workplace will best serve the needs of the supply side.

Use Questions:

1. **How does the vocational-technical education and training community use this type of information?**

In the "Background and Purpose" section the authors have provided the Indiana Scenario. The authors felt this was appropriate since Indiana is a state that is committed to many of the current initiatives faced by all states (school-to-work, one-stop shopping, skill standards, content standards, certification of skills, etc.)

In a separate action, the Executive Committee of the V-TECS Board of Directors was presented a proposal in February which addresses many of the issues in this paper. It was recommended that the NOICC Units of Analysis be considered as the scheme for identifying occupational clusters. Since then, the authors have been provided with the most current work being done on the Units of Analysis by the NOICC staff which further enhances the value of the recommendation. It is envisioned that the Units of Analysis as used in the state Career Information Delivery Systems (CIDS) will provide a valuable tool permitting multi-state surveys of the activities of incumbent workers in various occupations. The recommendation is that such surveys be conducted in a manner similar to the Indiana protocol or that of the better National Skill Standards Projects. By using the Units of Analysis, planning can be done to identify areas for analysis and enhance the placement opportunities of program completers or graduates.

As Indiana works to develop school-to-work programs (initially in plastics manufacturing) direct linkages to specific employers will use the protocol to identify the training needs, write training contracts, identify related instruction, and provide for the articulation of secondary students into postsecondary instruction with continuous employment under the apprenticeship system.

With the introduction of one-stop-shopping grants and the use of various certifying systems (certificates of initial mastery, certificates of technical achievement, portfolio systems, etc.) it is important that job titles and job analysis be consistent. Indiana's "open transcripts" will depend on consistent analysis, assessment, and reporting.

Indiana and seven other Great Lakes States (Minnesota, Wisconsin, Illinois, Michigan, Ohio, Pennsylvania, and New York) have entered into a contract to develop and promote the economic welfare of the region. One of the concepts of the "Great Lakes Guarantee" is that the workforce be transportable among the Great Lakes States. This, again, will require a consistent occupational analysis, assessment, and reporting process. In a world economy where the United States economic competitiveness is an issue, it would appear there is high value in a nationwide system.

It can be concluded that the vocational-technical education and school-to-work community are almost at an embryonic stage in use of labor market information and the discussion for this question outlines some of the potential uses in the foreseeable future.

2. How can the DOT/O*NET and SOC be used for statistical and planning purposes for the education and training environment as well as other users?

If the hierarchy suggested previously can be implemented, the SOC will be a more general category of related DOTs. DOT data can be aggregated to the SOC level. By collecting and reporting data, vocational-technical education and training providers in the supply side will provide the information required to develop relevant programs for the current workforce.

The following data sets should be considered to maintain a SOC information base for vocational-technical education and school-to-work curriculum developers, planners, and counselors:

Employment data:

Historical employment (currently 1984 levels)
Current employment (1995)
Average annual job openings (growth + replacement)
Hourly wages
Some form of a SVP

Supply Data
(Enrollments by Occupational Cluster)
Secondary
2 Year Postsecondary
College University
Adult Secondary
Proprietary
Apprenticeship
Military
Other

The authors realize that the SVP doesn't have much stock with the current DOT/O*NET and SOC developers, however, we believe the concept behind the SVP is important since it provides clues as to the structure of career ladders. Training time is probably a reasonably accurate descriptor since it considers both school based and work based preparation. The SVP concept should be modified to recognize the following five levels:

Level 5	CEO, Management Administration, Advanced Degree
Level 4	Supervisor, Basic Degree, Advanced Professional Certificate of Mastery

Level 3	Master Technician/Journeyman Level, Postsecondary Degree or Certificate of Mastery
Level 2	Specialist Level, Postsecondary Certificate of Mastery, Secondary Certificate of Mastery, On-the-job Training
Level 1	Trainee Exit Level, Position Entry Level, Secondary Diploma of Certificate of Mastery

The authors question the value of the General Education Development (GED) in its current form since it is difficult to measure given the current workforce data has become skewed with the increase of overly qualified people in jobs. It would be better to describe GED with concrete examples using the Foundation Skills Architecture of SCANS.

The authors also question the current DOT Physical Requirements and Environmental Conditions information as it tends to be too specific in the modern workplace where the organization of tasks should be flexible so as to increase the competitiveness of the industry in a world marketplace and where career ladders encourage the improvement of skills and movement from one employer or industry to another. However, it is important to know when a given occupation places extreme demands on individuals in terms of physical or environmental conditions. While a counselor cannot tell a client who is confined to a wheel chair that he or she cannot do something because the job requires them to lift 200 lbs, the counselor can provide this information for the individual and they can decide whether there is a fit based on their own analysis of their abilities against documented criteria.

One of the problems vocational-technical education and other training providers have experienced is that their programs tend to be static and not responsive to the fluctuations of the labor market. This is due in part to the traditional approaches we have taken to developing curriculum. It is expensive, traditional hard copy, and once implemented, many instructors are reluctant to change. However, this problem is exacerbated by the inability of vocational-technical education to locate and use labor market information. This is as much the fault of the supply side as it is with the demand side. However, if the barriers between agencies can be removed, a tremendous advantage will be realized on the training side to make programs more dynamic to the needs of the customer, the employer. The future DOT/O*NET and SOC are going to have to accommodate the needs of all users and with the introduction of one-stop, school-to-work and other initiatives, it is going to be important that the data in the labor market data base, both supply and demand be compatible. Maintaining the status quo relationships will only perpetuate the problems we are already experiencing.

3. How can a properly designed system be used as a framework for certifying workers in their various industry or occupational specialties?

Indiana's Certificate of Technical Achievement will look similar to a portfolio. It could be in a three-ring notebook with pages inserted or removed as appropriate or on a disk. It will be an owner-managed portfolio and will contain assessment results and other information a person may wish to include as a collection of pertinent documents representing their qualifications and achievements relative to employment, including work performance scenarios.

Such a system in the one-stop environment and given the regional considerations of the Great Lakes Guarantee (or any other regional consortium) will depend on a consistent method for documenting proficiency, skill attainment, etc. As a portfolio owner seeks employment, reemployment or to become more productive through progress in a career ladder, a consistent reporting system using a consistent set of titles will be crucial to enabling the counselor, placement officer, or participant identify jobs where there is a satisfactory "fit." In Indiana, certification is done at the duty/task level within the SCANS architecture. SCANS performance will be framed in the actual duties and tasks performed and will be contextual to an employer and/or industry. The system must be properly designed in order to afford these opportunities to the user (employment seeker).

4. How can the concept of a skills taxonomy be used as a common language for building clusters as well as for identifying common or transportable skills that cut across industry families/occupational clusters/specific occupations as well as geographic boundaries?

The authors have extensive experience in setting up and implementing a model to identify the literacy skills found in the workplace. They used the GED definitions found in the DOT as well as from other sources to develop a set of literacy skills. These skills were placed into a matrix and were coded to jobs and to an assessment of people in the workplace. The discrepancy between the people assessment and the job assessment was used to identify training needs.

The authors experience revealed that a consistent set of skills could be used in a variety of work environments and on a variety of jobs. V-TECS has a Basic/Essential Skills Taxonomy developed by Lester M. Snyder, Jr. at Arizona State University which could be used to craft a consistent set of academic skills that could be applied across occupational levels. Once a skill has been identified and verified as relevant to the workplace and is not redundant to another skill, it could be added to the database. In this way, at the skill level, occupations could be described in a common language. This does not preclude the possibility that a contextual qualifier couldn't be added to the basic skill.

In Indiana, the SCANS architecture is used as the common language for competencies or activities in the areas of Resources, Information, Interpersonal Skills, Systems and Technology. The SCANS competencies are described using the foundation basic and thinking skills. It is the intent of this system that at this level the skills become transportable. It matters not if someone reads a blueprint of a machine part or of a house plan. Reading the blueprint is the skill and the "machine part" or "house plan" is the context. The skill is transportable even if there is some minor adjustment to be made (i.e., metrics, scale, CAD, format, etc.).

The Indiana system allows for articulation by reporting duties, tasks, SCANS competencies and foundation skills. This common language allows employers to see in real-time language what the person knows and is able to do and, even though the person's specific experience may not be exactly what the employer is looking for, the employer has information in which judgments can be made on the transportability of the skills.

EPILOGUE

Our observations have been focused by our bias for the supply sector. We admit to being idealistic but we feel that in a collegial environment, the traditional barriers to a common classification structure between and among agencies collecting, reporting and using occupational information can be minimized. This is critical if we are to build a world class system that will open doors in the future rather than close them to all but the most specialized users of labor market and occupational information.

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Issues\Problems in Data Collection and Measurement of Occupational Information from Household and Establishment Surveys

Authors:

Joseph Waksberg
David Cantor
Kerry Levin
Jeffrey Kerwin
Jim Green

Westat, Inc.

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DISCLAIMER

This report was provided by Westat, Inc., Rockville, Maryland, under contract number F-4248-3-00-80-30-WST to the U.S. Department of Labor. The views and opinions expressed on the following pages are solely those of the authors and do not necessarily constitute an endorsement, real or implied, by the United States Government. We thank Paul Hadlock for important comments on the original version of this paper. This revised version contains much of the information he supplied. However, the analyses in the paper and conclusions reached are solely the responsibility of the authors.

EXECUTIVE SUMMARY

This report discusses the methodological and sampling issues that should be considered in collecting data using a skills-based SOC. This paper focuses on the SOC as a tool for examining the statistical issues involved in data analysis as opposed to a tool for purposes of selection, promotion, training, etc.

Data Collection Issues

The three principal sources of information on occupational data are: the BLS' Office of Employment Projections which are based primarily on the Occupational Employment Statistics (OES) surveys, supplemented by data from the Current Population Survey (CPS), Census, and certain other sources; the Decennial Censuses; and the Census Bureau's CPS. The methods used to collect occupation information on surveys are divided by the sample frame (establishment vs. household) and type of administration (self- vs. interviewer). These two dimensions provide constraints around which measurement issues are discussed. The sample frame is important because employers retrieve information from records. Respondents to household surveys retrieve information from memory. Self-administered surveys are limited by the complexity of the instrument, while interviewer-administered surveys have more flexibility with respect to skip patterns.

The discussion of specific issues related to collecting a skills-based SOC is organized into three sections involving: (1) household surveys; (2) establishment surveys; and (3) a comparison of household and establishment surveys. For the purposes of our discussion, "skills" are divided by skill type (distinguishing activities) and skill levels (education, training, and experience). To operationalize skill type on a household survey it is necessary to ask detailed questions on distinguishing activities. It may not be necessary to include direct questions on skill levels. Distinguishing activities may implicitly provide the required information. Australia, for example, adopted a skills-based classification system and includes two open ended questions on the census and labor force survey which are very similar to what is now included on the CPS. The reliability and validity of this approach, however, is uncertain. Experience on the CPS and Decennial Census has shown that obtaining information on distinguishing activities is a difficult task. As a result, the reliability of occupation collected on the CPS and Decennial Census is low because: (1) Collections methods are unable to effectively obtain the necessary details on activities; and (2) In many cases, names respondents use to describe their jobs do not correspond to the classification system. The validity of these data is uncertain, since there are very few studies that have been conducted that compare survey-based occupation data to an external measure of validity.

Future research should be tailored to the constraints of the particular survey. For the Decennial Census, where it will be difficult to add questions, research should focus on evaluating how the current questions can be used in conjunction with the new skills-based SOC. For the CPS, where computer assisted interviewing is available, research should evaluate combining the use of occupation name and targeted probing to collect information on distinguishing activities.

For establishment surveys like the OES, the primary issues concern: (1) whether information on skills is stored in establishment records; (2) how this information is stored; and (3) whether establishment definitions are compatible with the survey. To investigate this issue, anecdotal information was obtained from a discussion with the field staff of the Occupational Compensation Survey (OCS). These interviews revealed: (1) information on distinguishing activities and skill level is generally available in agency records; (2) this information is in a highly disaggregated level; and (3) only a small number of persons within the organization have access to the information. Research into adopting to a skills-based SOC should investigate the need to include explicit information on skill levels as part of the job descriptions on the survey form or rely on descriptions of activities and duties to implicitly include this information. Research should include gathering records and analysis of how respondents apply survey job descriptions when completing the survey.

One of the goals of the SOC is to crosswalk household and establishment data systems. Revision of the SOC has also considered establishing a single system that would be used by both the OES and the CPS/Decennial Census. To the extent that a single system is desired, the incompatibility of the two collection systems has to be considered. Previous research has found substantial differences in the measures provided by each type of survey. If there is a desire to integrate the two systems, these differences need to be examined in more detail.

Sampling Issues

Section 5 of this report discusses the sample sizes necessary to achieve acceptable precision for statistics on the detailed occupations, and describes limitations of the three principal sources of information on occupational data in meeting reasonable precision goals. The sampling errors depend on the sample sizes, and for any survey the sample size can be considered the total number of persons for whom occupation is reported or the numbers in subpopulations that will be analyzed separately (e.g., states, metropolitan areas, individual SIC groups). Furthermore, the sampling errors are also affected by the type of statistics analyzed. Three major types are discussed in the paper: estimates of the number of persons in each occupation and changes in this distribution over time; social and economic characteristics of the persons in each occupation (e.g., gender, age, race, median income, unemployment rate); and comparisons of the number of persons in each occupation under the current definition and a revised definition. Large sample sizes are needed for a study of comparability of two sets of definitions, and even larger samples are required for statistics on the characteristics of persons in each occupation.

An examination of the number of employees in each occupation reported in the most recent OES shows a wide range in the size of the occupations. (It should be noted that, as mentioned earlier, BLS uses additional sources of information in its projections of employment by occupation. Furthermore, data collection in most industries exclude many occupations for which representation in the industries is quite small. The projections impute for these exclusions using models based on data from other sources. Our analyses relate solely to the OES, but since OES is such a dominant part of the occupational projections, the comments apply approximately to the projections.) Half of all employment is concentrated in 46 of the 771 occupations. Conversely, the smallest 200 occupations account for only one percent of employment. Data for half the number of occupations would cover 95 percent of all employment. A relevant question at this time is on the value of revisions in definitions of the small occupations. The enormous sample sizes in the Decennial Censuses and the OES provide adequate precision for national estimates of the number of persons in all except a handful of the smallest occupations. However, the quality of state estimates is uncertain for possibly 100 to 300 occupations. For most of these small occupations, the effect of definitional changes is likely to be much smaller than the sampling errors and problems in the models used for projection. Other measurement problems will add even further to the difficulties of distinguishing between current and revised definitions for the small occupations.

The sample sizes and their implication on precision for occupational data are examined for the three principal sources of these data, and also address the need for a link study to provide historical comparability if revisions in definitions are made. (We note that occupational information is obtained in other Government surveys, generally as a part of a group of background variables rather than for inherent interest in occupations. They are not included in our analyses. We suggest that the secondary interest in occupation in these surveys is likely to create differences in editing and coding in these surveys and the ones we concentrate on which, in turn, would create uncertainty about comparability of data.)

The samples in the past several censuses contained about one-sixth of the population reported in the census. We assume that the same policy will be followed in the next census so that the sample will contain about 24,000,000 persons in the labor force. (There is still uncertainty about the form and content of the next census, and this assumption may have to be changed.) A sample of this size is sufficient to provide adequate precision for the U.S. occupational distribution for virtually all occupations. However, the quality of state data would be poor for some occupations, with the most severe problems occurring in the small states. For statistics on characteristics of persons in the occupations, the census cannot provide good quality data for the smaller occupations even at the national level. For state data, acceptable precision on such characteristics as employment rate will exist for only 200 to 250 occupations. The most recent census reported data for a smaller number of occupations than the OES, and it appears to be a reasonable way to proceed.

The CPS is carried out monthly with about 60,000 households containing about 85,000 persons in the labor force, There are about 300 occupations for which estimates of the number in each occupation could be shown with reasonable precision. However, since such current data are available from the much larger samples used in the OES, the main value of the CPS information on occupations is for statistics on the characteristics of persons in the various occupational groups. Moderately reliable data on characteristics could be provided for 150 to 200 occupations. A fairly conservative policy is followed in CPS, with the monthly labor force reports showing data for around 50 occupation groups. Since information on occupation, industry, and many demographic items is asked each month on the CPS, the effective sample size could be considerably increased with annual or biennial averages. To our knowledge, this has not been done. This sample expansion does not apply to analyses of income by occupation since income is only obtained once a year.

The OES is the major resource for current data on trends in occupational employment. The 1991-1993 study was based on a sample of 700,000 establishments containing tens of millions of employees. From the point of view of costs, household surveys cannot compete with data collection procedures used in the OES, and the OES will undoubtedly be the main source of employment statistics for the indefinite future. The sample size is large enough to provide data with adequate precision for all except a handful of very small occupations. The main limitations of the OES are the omission of the self-employed, the unemployed and many agricultural workers for which models based on CPS, Census and other sources are used. Regardless of the structure of SOC and the definitions used, comparability between establishment and household survey data will not be exact because employers and employees have somewhat different perceptions of the work carried out. It is not clear whether adding a skill-based component to the definition will narrow or widen the differences.

If important revisions are made in the SOC, it will be necessary to carry out a link study to measure the effects of definitional changes so that historical trends can be studied. Very large sample sizes are necessary to measure these differences in the smaller occupations. An efficient measurement method is to subject a sample to both types of measurements, and compare the results of coding occupation in both ways. Whether this can be done for future revisions depends on the amount of new information that will have to be collected, and whether the census or CPS are able to devote questionnaire space and interview time to the additional items of information. If no new items are needed, it would be relatively easy to go back to the 1990 census and recode a subsample of cases for which occupation was coded according to the old definitions. If quite different information is needed, there is likely to be difficulty in accommodating the additional items in CPS or the census. The only alternative may be in a split sample design for the OES or the census. This will reduce the sample using the new definition, as well as creating operational complexity. It would be useful to consider whether a link between the two systems is necessary for all occupations, or whether it could be restricted to major occupation groups and the largest occupations, perhaps 100 to 150 of them.

PURPOSE AND BACKGROUND

1. Overview of Paper

This paper discusses the issues involved in the collection and measurement of occupation information. It specifically focuses on the SOC as a tool for examining the statistical issues involved in data analysis as opposed to a tool for use in selection, promotion, job placement, etc. This Section presents an overview of the methodological and sampling issues to consider for a new SOC. Sections 2-5 focus on findings and implications and are organized as follows:

Section 2: Discusses a skills-based SOC for household surveys;

Section 3: Discusses experience on the Occupational Compensation Survey;

Section 4: Compares household and establishment surveys; and

Section 5: Discusses sampling issues related to a new SOC.

Section 6: Presents the methodological and sampling issues as they relate to considering a skills-based SOC.

1.1 Overview of Surveys

There are three principal databases that are used to analyze occupational distributions and trends; BLS's Occupational Employment Statistics (OES) surveys, the Census Bureau's Decennial Censuses, and the monthly Current Population Surveys (CPS). The characteristics of the three statistical systems are well known and are described in R. Dempsey's report "An Occupational Classification System for Collecting Employment Data from Both Households and Employers." A brief description of the three sources follows.

The Decennial Census conceptually includes the entire U.S. population and thus covers employees in private industry, Government (federal, state, and local), agriculture, and the self-employed. It includes employed and unemployed persons and those who are out of the labor force but worked within the five years prior to the Census. The sample sizes have differed somewhat over the past few censuses, ranging between 20,000,000 and 25,000,000 persons in the labor force. Prospects for the next census are somewhat clouded because of Congressional pressures to reduce budgets and Census Bureau consideration of what is referred to as continuous measurement. Considerable lead time is necessary to get agreement and test new questions on the census, and members of the Census staff have informed Westat that it is close to the census' deadlines.

The CPS is a monthly household survey of about 60,000 households containing approximately 85,000 persons in the civilian labor force. Sample households are slowly rotated in and out of the sample, and, in the course of a year, there are about 175,000 separate households containing about 250,000 labor force members. The number of times occupations are reported is actually somewhat larger because persons changing jobs during the year could report more than one occupation. CPS traditionally uses the same classification system as the census, and when classification revisions are made in the census they are introduced in the CPS soon after. The population coverage in CPS is almost as great as in the census; the only exclusions are the military and institutionalized persons. CPS is carried out by the Census Bureau, but since BLS is responsible for the analysis and preparation of reports on labor force items it has a major role in decisions on the content and wordings of the questions and classification issues.

The OES is a very large establishment survey that is carried out over a three year period. The most recent survey was conducted in 1991-1993 and covered 700,000 establishments. Its coverage is not quite as comprehensive as the census or CPS. It is restricted to private businesses and Federal, state and local governments. It thus omits most farm workers, the self-employed, the unemployed, and persons not in the labor force.

BLS uses additional sources of information to compensate for the omissions in its projections of the numbers employed in the various occupations. Furthermore, OES data collection in most industries exclude many occupations for which representation in the industries is quite small. The BLS projections impute for these exclusions using models based mostly on CPS and Census data. Our analyses are restricted to OES data, but since the OES is such a dominant part of the occupational projections, we believe the conclusions also apply approximately to the projections.

The large samples in the Decennial Censuses and the OES provides adequate precision for national statistics on almost all occupations in the classifications used in the surveys. However, considerable grouping is necessary for the much smaller CPS sample. Employment data from the CPS is generally restricted to about 50 occupation groups. It would be possible to provide more detailed occupation data from the CPS by combining data for a group of months, e.g., deriving an annual average, or even an average over three years as is done in the OES. We are not aware of this having been done. Presumably, users have not expressed such a need to the Census Bureau.

There are, of course, other surveys that obtain occupational data, but they are of smaller size, carried out for special purposes, or done intermittently. They include such studies as BLS's Occupation Compensation Survey and the Census Bureau's SIPP. Almost any population survey that includes economic characteristics of the population is bound to have questions on occupation. For example, the National Health Interview Survey (NHIS), a 45,000 annual survey carried out by the National Center for Health Statistics and largely devoted to health characteristics and health care, includes occupation as part of the demographic and social background variables. We will not include such surveys in our discussion although it would be possible to think about an annual (or biennial) statistical series that combines data from all Government-sponsored surveys that include questions on occupation. We note that before such a combination is made, the quality and care given to editing and occupation should be analyzed. It is possible that surveys in which occupation is only of peripheral interest, e.g., the NHIS, do not expend as much care into editing and coding occupation as surveys in which the main focus is on economic items.

1.2 Overview of Data Collection Issues

The methods used to collect occupation information differ by the nature of the respondent (i.e., establishment vs. household), as well as the type of administration (i.e., interviewer administered vs. self-administered). Table 1 provides this basic topology and includes examples of surveys that are conducted by the federal government that fall within each cell. Establishment surveys collect information from employers. This information is drawn from existing records or, in the case of small firms, personal knowledge of the company informant. Household surveys collect information from the self reports of job incumbents[1]. Logically, one would expect that the employer in the establishment provides the information from the demand side of the economic equation, while the job incumbent provides it from a supply side of the equation. For example, in a skills-based occupational system, it is expected that employers are more likely to supply information on what is required to do a particular job, where as job incumbents are more inclined to provide information on the qualifications/skills that they actually have (USDL, 1993: 180).

The type of administration provides the context within which questions are presented to respondents. Interviewer administered surveys are provided through auditory communication, while self administered surveys are delivered through a visual medium. These differences are correlated with the amount of information that can be presented to the respondent. Interviewers can follow skip and branching patterns in the questionnaire. If desirable, they may even be trained to conduct relatively unstructured interviews. On a self-administered form, there is a limit to the skip patterns that can be presented, at least at the present time.[2] When switching to a skills-based occupational system, these differences are relevant because they provide basic constraints on the type of questions that can be asked. Interviewer administered instruments allow more flexibility on embedding contingent skip patterns than self-administered forms. For example, adding questions to the Decennial Census form may be difficult because it will increase the perceived burden. Adding branches to a computer administered personal or telephone survey (CAPI or CATI) will not be as difficult as long as any particular respondent does not receive significantly more questions.

In the abstract, issues related to collecting information for a skills-based SOC are relatively straightforward. Once an operational definition of "skills" is developed, questions and coding procedures can be developed to accommodate these definitions. Whether it is possible to obtain accurate information is then only a matter of finding out if respondents have the appropriate information and how best to communicate the concepts. This abstract process, however, has to be viewed in the real world where resources are limited and surveys do not have unlimited time to devote to collecting occupation information. Therefore, when addressing collection issues related to a SOC based system on skill, it is important to understand the priorities and resources devoted to the collection of occupation information within the particular survey of interest. As will be illustrated below, collecting occupation data is not a simple task, especially when trying to get very detailed information (e.g., three-digit Census codes). As one might logically expect, the amount of time and effort devoted to collecting this information will directly affect whether it is feasible to switch to a new system, as well as the quality of any resulting data that is collected.

Neither the Current Population Survey nor the Decennial Census places a high priority on collecting occupation information. The primary purpose of the CPS is to collect information on labor force and employment status. While clearly occupation is an important part of understanding the labor force situation, it is not as important as these other two goals of the survey. Similarly, the Decennial Census provides very important information on occupation for local areas. However, this purpose is embedded within the overall goal of the Census to collect numerous other characteristics on the U.S. population.

These priorities are reflected in the resources used to collect the information. Both of these surveys use two open-ended questions to collect the data required to code subjects into an occupation group. For the CPS, these questions are:

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[1] For purposes of this paper, the distinction between self and proxy respondents is not made.

[2] As the use of computerized self-administered questionnaires become more common, this limitation will be less relevant.

1. What kind of work do you do? That is, what is your occupation? (e.g, plumber, typist, farmer); and

2. What were your usual activities or duties at this job (e.g., Types, Keeps account books, Sells cars, Operates printing press, Lays brick)?

Preceding these two questions are items on the type of industry the respondent works in. For the CPS, these data are collected at the end of the interview. Very little time is devoted to this portion of the instrument and very little time is spent training the interviewers to collect this information (e.g., providing guidance on the appropriate probes). Because the Decennial Census form is self-administered, respondents have little guidance on the information the question is seeking and very little space to write down the information. Despite the fairly intricate definitions associated with a particular three-digit category, Census/CPS coders are trained over a relatively short period of time. As part of this training, they are not provided with detailed descriptions of the content of particular jobs. The coding is primarily done by matching the occupational name from Q1 above to an alphabetical list of occupations.

For surveys that include occupation as a major priority, more time is spent obtaining an accurate measure. On one extreme, the Occupational Compensation Survey (OCS) is a survey of businesses with an in-person interview. The purpose of the survey is to assist the government in tracking wages in the private sector for occupations comparable to work performed by federal employees. This survey can take several hours to administer. Much of this time is spent by a highly trained field economist "matching" private sector and government occupations. This is also reflected in the hiring and training of the interviewers. Interviewers are generally required to have a BA or MA in economics and are trained over a 6-8 month period in the unstructured protocols administered to establishment respondents. For purposes of this survey, getting a clean measure of occupation is especially important. Consequently, the survey devotes extended periods of time to make sure the data collected on occupation is as good as it can get.

The Occupational Employment Survey (OES) is also an establishment survey which involves a cooperative agreement between BLS and the states. A priority of the survey is to collect information on the distribution of workers by occupation for purposes of generating small area estimates. The information is used for many purposes, including assisting in job placements. The OES is a self-administered instrument. Unlike many self-administered instruments, however, it attempts to explicitly define the meaning of particular occupational titles to the respondent. This is accomplished by placing these definitions adjacent to the titles on the survey form. This maximizes the chances that the respondent will use the information. The OES coders are highly trained. When encountering difficulties in interpretation, they call up the employer to clarify the information (Dempsey, 1993).

How will implementing a skills-based SOC affect existing systems? Adding or perhaps even changing existing items to the Decennial Census is a major undertaking. It not only affects the resources needed to print and process the information, but could have an effect on the overall response rate by increasing the perceived burden of the form. Adding questions to the CPS or the OES, may not be as problematic, especially if the items could make the data collection process more efficient.

1.3 Overview of Sampling Issues

Since an important function of the SOC is to be a tool for statistical analyses, statistical considerations should have a role in the planning and decisions. These considerations cover issues of sample size and the level of detail that are possible with the surveys currently providing occupation statistics. We note that there is a reciprocal relationship between sampling the SOC. On the one hand, a requirement to provide reasonable data for each occupation in the SOC (or most of the occupations) has implications for sample size and the sample design. On the other hand, it would be useful to take into account implications of sample size and sampling procedures on the development of a revised SOC. A related concern is the sample size necessary for a linkage study of the old and the new SOC to permit historical comparability.

FINDINGS AND IMPLICATIONS

2. Towards a Skills-Based SOC for Household Surveys

Skills can be defined in a number of different ways. At this point in time, there doesn't seem to be a consensus on the definition. Among other things, it could include education, training, abilities and experience. For purposes of the discussion below, it is assumed that the system would be based on the Canadian National Occupational Classification System, as adopted by BLS (Table 2). This system is divided into two dimensions:

1. Skill types - the type of work performed. This is a combination of the industry group of the occupation, as well as the distinguishing activities and duties associated with the occupation; and

2. Skill levels - this is based on the amount of education, training and experience that is required to perform the job.

What would be needed to classify individuals into such a system on a household survey? Two different approaches to collecting this information will be discussed below (1) asking detailed information on distinguishing activities of the job and (2) asking directly about skills. These alternatives are not mutually exclusive and could be implemented in some combination.

2.1 Questions on Distinguishing Activities and Duties

From the definition of skills above, it seems clear that at least one set of items on the questionnaire would have to ask about the primary activities and duties associated with the job. This is required, for example, to place the job within the columns of the matrix displayed in Table 2. Subsequent questions on skill levels may not have to be asked, if activities and duties uniquely define a particular occupational category.

Activities and duties are collected in the open-ended questions included on the CPS and Decennial Census (see Q2 in Section 1). However, as currently structured, classification is largely dependent on the coder's decisions to match the occupation name provided to Q1 to the alphabetical list of names within the coding manual. The responses to Q2 (major activities and duties) leads to information that, in many cases is redundant with what is supplied in Q1, or may conflict with the occupation name.

Asking about distinguishing activities/duties is a difficult task. These difficulties are rooted within the nature of the classification system, which is not currently based on any simple set of underlying dimensions. One problem is that groups are defined by such criteria as the work setting, industrial classification, objects that are used in the work or educational/training requirements (Hodge and Seigel, 1966). Which of these criteria is important depends on the particular job of interest. A nurse, for example, can be classified into one of several categories depending on the level and type of training. A "machinist" can be classified into one of several categories depending on whether set-up and operation are required. In many instances these distinctions not only differ at the three digit level, but also cut across occupational groups. As a result, it is difficult for interviewers to probe for adequate information about the job.

A second problem associated with the classification system is that it is hard to communicate to the respondent what constitutes his/her "major or usual activities." For example, an individual who is supervising some of the time, but also engaging in non-supervisory activities, may never report the fact that he is supervising at all. Conversely, the respondent may report both the supervisory and non-supervisory activities, but not provide the interviewer with any sense as to how important each type of activity is within his/her job. Interviewers may not probe for this information. When coding from interview information, therefore, coders do not have the information needed to make an informed judgment. The incompleteness of the descriptions provided in Q2 makes the task of classification into a three-digit code very difficult. There are also severe time pressures associated with both the CPS and the Decennial Census. As a result, coding rules have been adopted that speed the process but lead to an even higher reliance on occupational title in the classification decision. The coders are not given reference materials on the types of activities and duties that describe particular occupations. Consequently, there is very little incentive to use Q2.

The data collected from these open ended questions, at least from the CPS, are unreliable for many purposes.[3] Gross flows across three-digit occupational categories for the CPS, for example, find that 30% or more of the subjects are measured as switching occupations in consecutive months.[4] This compares to estimates of actual change to be between 2.5% - 9% (Collins, 1975; Westat, 1991).

This low reliability in the CPS measure of occupation was the major reason for instituting a dependent interviewing procedure in the current redesign of the CPS questionnaire. In addition to the difficulties with collecting information on activities and duties, there are several other reasons for this low reliability. One is that respondents may change their responses to the items, depending on the context of the interview and what may be going on at their job at the time of the interview. Other reasons are due to the transcription and coding process itself, which may affect what words are used to describe particular occupations. Since the coding process uses a highly structured rules-based system, subtle wording changes may result in changes in the three-digit codes assigned to particular occupational descriptions.

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[3] It should be noted that whether one thinks a particular measure is unreliable is dependent on how the information is being used. Hauser and Featherman (1970), for example, report very high reliability of occupation information for the purposes of computing occupational prestige scores. This, however, is a much different task than trying to use the information for activities such as job placement, where accuracy at the 3-digit level could be quite important.

[4] About half as many are found to switch major occupational categories.

The validity of these measures are also open to question. The names used by respondents to describe their occupations may not correspond to the definitions associated with the SOC. However, there have been very few studies that have measured the validity of these open ended items. The only validity studies that have been conducted have compared job incumbent responses to measures collected from employers (e.g., Walsh and Buckholdt, 1970; Mellow and Syder, 1983, U.S. Census, 1977). For these studies, it is not clear which measure represents the best indicator of occupation (see Section 5). One possible exception is a study by Mathiowetz (1992), which conducted telephone interviews with job incumbents using the CPS/Census questions. Responses to the interviews were directly compared to company records within a large manufacturing firm where "accurate job descriptions .....are required and monitored by a strong union for the purpose of determining hourly wage rates" (p. 354). Experienced occupational coders independently classified the job from the interview and the company records. The rate of disagreement was quite high. At the three-digit level, 48% of the codes did not agree, while 24% of the codes did not agree at the major one-digit level. If one believes the company records as the "truth," then, one has to seriously question the ability of the household questions to measure occupation, at least at the three-digit level.

A related, but alternative, approach to the use of the open ended questions is to rely on the respondent to classify him/herself into a category. This method presents a list of occupation titles and asks the respondent to select a particular category. On a self-administered form, this list may have examples or definitions associated with each title. This method primarily relies on the context of the list to provide the respondent with a definition. The assumption is that if the respondent's definition of the occupation corresponds to the survey definition, then it is not necessary to ask about distinguishing activities or duties. This approach has been used in a number of surveys which do not have the resources to convert open-ended responses into occupation categories. For a mail survey, this method may require reduction in the number of categories for which respondents are asked to provide information. For an interviewer administered survey, however, a relatively detailed version of this can be administered. This process is speeded along with computer assisted interviewing, where branching and skips can lead directly or almost directly to the final code.

Direct comparisons between this self-coding and use of open ended questions shows substantial differences between the two types of methods. Taylor (1976) directly compares self-coded responses to those using the open-ended questions above for 10 major groups.[5] He found that between 55% and 61% of the occupations matched between the two classification methods, depending on the version of the self-administered form. In a more recent study, Hardy (1994) used both open and closed ended approaches. The coders used the self-classification as a basis and then changed the classification if there was evidence from the open-ended data to indicate that the best classification was not as indicated by the self-response. Using this method, the self-code was changed at different rates, depending on the type of occupation. It ranged from 33% for social scientists to 5% to computer science related jobs.

In a study conducted as part of the redesign of the CPS (Westat, 1989), substantial disagreement was found between the three-digit code derived from the open ended question and respondent reactions to this derived code. In this study, respondents were asked to react to the title of the code that was assigned to their responses to the open-ended descriptions. About 50% of the respondents disagreed with this code. Of these, half selected an alternative provided by the interviewer, while the other half provided their own title to select the occupation.

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[5] These included (1) professional and technical, (2) managers and administrators, (3) sales workers, (4) clerical workers, (5) craftsmen, (6) operatives, (7) laborers, (8) farmers and farm managers, (9) farm laborers, (10) service workers.

Several studies have found that for relatively high levels of aggregation, picking titles from a list is reasonably reliable (Winch, et. al., 1969; Eckhardt and Wenger, 1975). However, it is unclear how valid the occupations are. Some evidence comes from the study by Hardy (1994) mentioned above, which asked focus group participants to use both methods of classification. The two methods were then compared to the "actual" code which was derived by collecting in-depth information from the respondents. Of the 34 respondents, 24% and 32% of the responses were considered incorrect for the self-coded and open-ended methods, respectively. These data are very limited because of the small sample sizes and the restricted nature of the occupations included in the study. Despite these caveats, these results are interesting because they may imply that the self-coding method is superior to the open-ended methods that have been traditionally used.

This discussion leads to several implications for developing a new SOC:

1. When developing the new SOC, some consideration should be given to how occupational labels provided by respondents correspond to the classification system. As noted above, for both the open-ended and closed-ended approaches, there is a heavy reliance on occupational name. While questions should be developed to place less emphasis on this name (see below), future systems will still be highly dependent on this relatively simple way to summarize complex phenomena. Consequently, the level of detail associated with the SOC should be reasonably compatible with how respondents think and talk about their occupations;

2. More structured questions should be developed that assist the respondent in knowing what information is required. For certain occupations, it may be possible to rely on respondents to self-classify themselves into a particular group. However, this method is not likely to work for a number of occupations, which would need to be combined with more detailed descriptions of distinguishing activities and duties; and

3. As part of the development of the system, studies should include measures that validate the survey information. This is critical in trying to understand the problems with the system and evaluating the utility of different collection methods. External measures of validity would rely on more detailed job analysis methods used by Industry and Organizational psychologists.

2.2 Questions on Skills

The second dimension associated with the definition of skills is the skill level. For the matrix presented in Table 2, there are 5 levels:

Level 0 - Management education, training or experience

Level 1 - University degree

Level 2 - Two to three years of post-secondary, training or specific experience; or two to four years apprenticeship

Level 3 - High school degree preferred; up to two years of on-the-job training, specific work experience, or training courses

Level 4 - High school degree not required; short work demonstration or on-the-job training.

This is a combination of education, training and on-the-job training.

Whether one needs to include direct questions on skills is not entirely clear. It would depend on whether questions on distinguishing activities and duties could be developed that uniquely identify the occupations of interest. In many cases, if one is performing a particular activity that, *a-priori*, requires specific training or experience, then knowing these activities provides the information on the level of skills required (Wootton, 1993: 332). For example, if an individual reports that he/she is conducting open heart surgery, then the level of training and skill is implied by the activity.

This approach, in fact, has been adopted by Australia when switching to a skills-based occupational classification system (Madden and Tam, 1993). The switch in the 1980's did not include a substantial change in the open ended questions that are asked on their census or labor force survey, which are essentially the same open-ended questions that are used on the CPS/Decennial Census. This system also relies on the use of occupation name as the primary method of identifying distinguishing activities.[6] The Q2 equivalent for the Australian surveys is used about 50% of the time when classifying occupations. When switching to the skills-based system, they considered adding questions to their surveys to get more specific information on activities. This was rejected because of the difficulties with including questions that may only apply to a small subset of respondents. At this point in time, it is not clear how well this approach has worked. No studies have been found that have examined the quality of the classifications that resulted when revising the system.

The Australian Census has a number of items regarding the individual's job qualifications. For example, people who have left school are asked if they have obtained a trade certificate or degree since leaving school, what their highest level of education is, their main field of study and the type of institution they attended. They've considered incorporating responses to these questions into the coding of occupations, but are reluctant because these refer to the subject's total set of qualifications, rather than the skills/education they need for their present position.

There are related advantages and disadvantages associated with adding specific questions on skills. One advantage is that it provides a relatively concrete set of criteria that can be collected on a household survey. Asking about education, at least, is relatively straightforward. It should be noted, however, that the current questions on education included on the Decennial Census or CPS would not be adequate to meet these needs, since they refer to educational achievement, rather than educational requirements to fulfill the job. Exhibit 1 provides examples of questions on education and training that are currently being considered on a project that is revising the DOT (AIR, 1995). These questions are part of a larger job analysis that is geared toward revising the DOT to a skills-orientated system. These items are intended to cover a relatively broad range of occupations. On a household survey, these questions would provide the survey analyst information that, at the very least, would supplement information on distinguishing activities.

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[6] Information on the Australian system was obtained from a conversation with David Hunter of the Australian Bureau of Statistics.

A disadvantage of asking direct questions on skills is that they would add to the length of the survey instrument. As illustrated in Exhibit 1, these questions are dependent on the general type of occupation the person is in. For a computerized instrument, this may not be a significant addition to the instrument. However, for self-administered instruments, such as the Decennial Census, it would require significant compromises in the level of detail that would be collected.

3. Towards a Skills-Based SOC for Establishment Surveys

The basic issue related to methods to collect a skills-based SOC for establishment surveys revolve around how information is stored in establishment records and whether this information is compatible with survey definitions. Research on the response processes involved in establishment surveys indicates that respondents provide information to a survey using the definitions in their own record system (Edwards and Cantor, 1991). If the system is incompatible with survey definitions, the respondent may not adopt the information from the records to the survey. In research associated with the Current Employment Statistics Program (Ponikowski and Meily, 1989), for example, it was found that many establishments were simply unable or unwilling to provide requested information regarding employment that was consistent with the survey's definition. Instead, information was given that was consistent with the establishment's definition, which was often dictated by the constraints of their recordkeeping system.

The extent to which information in establishment records is consistent with a skills-based SOC is not known at this time. Intuitively, one would expect that information on the minimum job requirements for particular job openings would be in establishment records. At the very least, the activities and duties to be performed within particular jobs should be known, since this is needed to fill job vacancies. A critical data collection issue is whether this information is stored in ways that are compatible with SOC definitions. Self-administered surveys that collect occupation information rely on the respondent to scan job titles and match these to existing occupations within the establishment. To date, however, it is unclear how these definitions are applied by survey respondents when there is a conflict between the agency records and the survey. As mentioned in Section 1 above, the OES facilitates this process by providing respondents with specific definitions of what each of the titles means adjacent to the particular questions. The OES relies on a set of core staff who are in contact with employers within each state. This provides the opportunity to work with particular employers as questions arise and data quality issues come up (Dempsey, 1993). However, there are few studies that have examined the correspondence between survey definitions and how OES respondents use them when providing data.

In order to explore the issue of the content and structure of establishment records, it is useful to draw from the Occupational Compensation Survey (OCS). The OCS implements a classification system that is based on specific types of distinguishing activities and duties. Within each of these types, there are certain "levels" based on a number of criteria (e.g., job experience, decision-making responsibilities). As described above, the OCS interviewer (or field economist), spends a significant amount of time identifying the duties and activities required for the company's occupations. Given this, staff on the OCS should be in a position to provide information on the nature of establishment records and how they conform to an occupational system based on skills.

To explore this possibility, the authors met with members of the OCS field staff to discuss several issues:

1. What kind of information is available on the activities and duties of specific occupations within establishments?;

2. What kind of information is available on the skill levels associated with occupations within establishments?;

3. How is this information organized in the establishment records?; and

4. How often does this information conform to the categories in the OCS system? When the information does not conform, how difficult is it for the respondent to provide the information?

The OCS staff provided a number of interesting insights into each of these questions. It should be emphasized, however, that the following discussion is based on anecdotal information conveyed in a 1.5 hour discussion with the staff.

First, the OCS staff reported that information on activities and duties is available within the establishment. Larger companies that have a formal compensation program will keep this information in records, small companies without a compensation program will have this as personal knowledge of a key employee (e.g., owner, personnel director). The information is generally associated with formal job descriptions. The most likely person to have the information is the person that deals with employee compensation. While this information is available, OCS staff find it difficult to ask about. When understanding the content of particular jobs, the interviewer generally starts by understanding the organization of the firm, working from the top to the bottom. Questions are phrased in "compensation language" in order to best communicate the details of particular job types. For example, reference might be made to different scales used by compensation personnel to measure experience required for the job and job complexity. Generally speaking, the more levels (e.g., skill levels) within a particular occupational group (e.g., engineer), the more difficult it is to pinpoint what job category it fits into.

Second, OCS staff felt that data on education and training are part of most job descriptions and would be more available than detailed descriptions of the activities and duties of the job. As with activities and duties, the source of this information may vary, depending on the size of the company. In a small company, there may be no formal job descriptions and the owner may have to provide them from his/her own personal knowledge. In larger companies, where there are more formal job hiring procedures, it should be part of the job description. Data on other skill attributes, such as interpersonal skills and cognitive abilities, are not available in records and would be very difficult to measure directly. These would have to be inferred from the job descriptions. The OCS staff hypothesized that in very small firms, where there is no formal compensation system (i.e., records), there might be a danger of respondents misinterpreting questions on education/training as referring to the education/training of the person who actually holds a particular position. This might occur when a respondent retrieves the information about a job by either directly asking the job incumbent or thinking about the particular skills/abilities the individual may have.

Third, the information on education/training is generally stored in a highly disaggregated form. Specific job descriptions may refer to a relatively small portion of a statistical system like the SOC. The OCS staff cited the example of an accountant, which might have a number of levels within a company but only a single category in the SOC. In order for the respondent to provide the information, therefore, he/she may have to aggregate across a number of different job descriptions. They also noted that while the information is generally available in the records, it is not widely available among company staff. Therefore, in order to access job descriptions, a relatively high level person associated with the company compensation policies would have to provide the information. They noted that when the OCS field economist set up appointments to interview at companies, they make a strong effort to find the person who knows about the activities and duties for the jobs within the company. Even when doing this, however, they frequently find themselves talking to a person who is not knowledgeable about these details.

The OES, and other mail surveys, contrast with the OCS in several important respects. First, as a mail survey, there is not much opportunity to ask specialized questions about activities and duties for particular jobs. Instead, these surveys rely on the ability of the respondent to read job names/definitions and associate these with equivalent jobs within the organization. Second, the OCS has the opportunity to find the correct respondent. For a mail survey, there is much less control over who will eventually fill out the form. This difference reinforces what is well known for establishment surveys --- it is important for the appropriate person to fill out the survey. There is likely to be only one or two persons within the organization who has access to the of the appropriate information.

Given the constraints on mail surveys, it is likely that there would not be substantial changes in the way surveys like the OES would be redesigned.[7] They would still rely on occupational title and descriptions as a way of communicating definitions. Based on the comments from the OCS staff, the important issues related to adopting a skills-based system involve how best to communicate these definitions, given that respondents may not be the most knowledgeable individual in the establishment.

4. Comparison of Household and Establishment Surveys

One of the goals of the SOC is to crosswalk the data provided on the OES and CPS/Decennial Census. Revision of the SOC is also seriously considering establishment of a single system that would be used by both surveys. Currently the SOC does provide a link between these two surveys. However, there have been very few comparisons of the empirical results of the two systems. This comparison, of course, is complicated by the fact that the OES does not cover all types of businesses that are covered by the CPS (e.g., self-employed workers) and that one measures jobs and the other measures job holders.

Previous research on the measurement of occupation information has found there to be substantial differences in the measures provided by establishment and household surveys. For example, Mellow and Syder (1983) found that when comparing reports by job incumbents to data collected from employers, the agreement rate at the three-digit level was around 60% and around 80% at the major 1-digit level. Similarly, as part of an employer record check study conducted after the 1970 census, comparisons were made between the census occupation codes and those collected from employers using a self-administered questionnaire (with open ended questions). At a major group level, this study found that approximately 78% of occupations matched between employers and the Decennial Census. See, also, Walsh and Buckholdt (1970) and Westat (1989) which find similar results using slightly different designs.

What accounts for the different results between the household and establishment surveys? One interpretation is that the employer is providing a superior measure and that the differences between the two are indicators of problems with the report collected from the job incumbent. However, establishment surveys are also subject to many of the same problems household surveys have including:

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[7] As noted in the introduction, these constraints are quite different if one moves to a computerized self administered instrument.

1. The employers records may not be complete or accurately reflect the type of work the employee is doing;

2. The employer may use occupational names that are established within the company, but do not have the same meanings with respect to the survey's classification system;

3. The employer may not understand the level of detail that is required by the survey; and

4. The wrong respondent fills out the questionnaire. The person that is most knowledgeable about particular job descriptions may not be the respondent.

All of these factors make it difficult to say exactly why the two measures differ and which is better.

There is a conflict between household and establishment information needs. Household respondents use labels that are related to general job duties and responsibilities. Establishment survey respondents report very specific job duties and responsibilities. Trying to design an SOC that spans across the two systems may pose problems balancing these demands. Household surveys may not be able to accurately classify jobs at a detailed level of aggregation (e.g., three-digit Census codes), while establishment survey respondents may have records at too detailed a level.

Notwithstanding these survey related issues, the cognitive/information bases from the two systems are fundamentally different. Establishment surveys view the jobs from the point of view of what qualifications/duties define the position (demand). Household surveys provide the point of view of what the employee brings to the job (supply or human capital). These fundamental differences are also likely to be reflected in how respondents provide information about occupation, regardless of the way the questions are phrased to approach the concepts from one perspective or the other.

5. Sampling Issues

It is useful to start with the effect of sample size on the ability of a household survey to provide data on detailed occupations since both census data and the CPS are based on samples. Household surveys are rather blunt instruments for the collection of occupation data. It is not possible to focus household samples on specific occupations (unlike an establishment survey where oversampling of industries with higher frequencies of rare occupations is possible). None of the samples for household surveys we are aware of is designed to improve the precision of data for small occupations. In fact, the oversampling that is done (e.g., higher sampling rates for the less populous states in CPS, plans for oversampling low-income households in future cycles of SIPP) tends to reduce the effective sample sizes for national statistics on such items as occupation. Our analyses will therefore be restricted to equal probability samples in which all households have the same chance of selection.

Exhibit 2 shows the estimated number of employed persons in each of the 771 occupations reported in the 1991-1993 OES. The occupations are arrayed in descending size order. There is, of course, a wide range in the sizes of the occupations. Half of all employment is concentrated in 46 of the 771 occupations. Conversely, the smallest 200 occupations combined account for only one percent of employment. Data for half the number of occupations would cover 95 percent of all employment. An analysis of the sample sizes necessary for reasonable precision for statistics on occupation follows.

Precision, of course, depends on the sample size and the sampling errors are related to the number of sample cases for the various occupations studied. The relative sampling errors (i.e., the coefficients of variation) in a survey will thus vary greatly among the occupations, and the larger occupations will be subject to much smaller percentage errors than smaller occupations. How large a survey needs to be to provide adequate occupation data thus depends on the cut-off for occupation size that can be tolerated.

$$1/\sqrt{n}$$

A rough guide to the sampling error is that the coefficient of variation is approximately: where n is the number of sample cases found for the occupation being examined. Thus, if 5 cases occur in the sample, the proportionate sampling error is about 45 percent, if 25 cases occur, the coefficient of variation is 20 percent, etc. A reasonable approach is to have greater precision for the more common occupations than the rare ones. In fact, it would be difficult to avoid such a situation.

Table A contains the household sample necessary to achieve several levels of sample size in an occupation. The number of households needed depends on the smallest size of the occupation for which data are desired. The table shows the rank of the occupation at each size level and lists one or two occupations at the size shown. The smallest size listed is 1,000, and there about 20 occupations with fewer numbers of employees. We note that the sample sizes are in terms of number of interviewed households, and it is necessary to add an allowance for nonresponse.

Many of the smallest occupations in the OES, that is those of 1,000 or 5,000 employees, are probably artificially low because they were not included in the questionnaires for most industries or because they were residual categories listed as "all other..." for occupations divided into subclasses. With a few exceptions (mainly Federal Government employees), the BLS projections for occupations for which the OES provides only a minority of the employment are mainly based on models. For those occupations, the model errors are likely to be the most important factors affecting the quality of the BLS projections, and they may dominate the sampling errors. Presumably, the CPS and Census estimates are not subject to the same limitations. The OES tabulations may therefore understate the size of the smaller occupations. However, even if the smallest 100 to 200 occupations are understated by as much as 50 percent, the analysis that follows approximately applies. If the understatement is greater than 50 percent, then for purposes of national projections, most of the estimates come from models rather than OES (except possibly for a small number of selected industries or states). We concentrate on national estimates in this paper and assume the OES provides approximately correct figures on the occupations.

Table A. Number of screened households needed to locate specific number of employed persons, by size of occupation

(Without allowance for nonresponse)

Occupation			Number of sample persons in occupation				
Size	Rank	Example	5	10	25	100	250
1,000	750	Pattern makers, wood	500,000	1,000,000	2,500,000	10,000,000	25,000,000
5,000	676	Elevator Operator	100,000	200,000	500,000	2,000,000	5,000,000
10,000	604	Dancers, landscape, architects	50,000	100,000	250,000	1,000,000	2,500,000
25,000	444	Screen printing, machine setters, economists	20,000	40,000	100,000	400,000	1,000,000
50,000	333	Hand cutters and trimmers, physician's assistant	10,000	20,000	50,000	200,000	500,000
100,000	213	Travel agents, messengers	5,000	10,000	25,000	100,000	250,000
250,000	102	Administrative managers	2,000	4,000	10,000	40,000	100,000

How large does a survey need to be to provide useful data on the occupational distribution? There is, of course, no simple and universal answer. It depends partly on the analysts' needs for data on the small occupations. It also depends on whether the analysis is restricted to national figures on the number of persons in each occupation, whether state or local-area data are desired, and whether social and economic characteristics of persons in each occupation are needed, (e.g., unemployment rates, mean income, distribution by race, gender, or age). We note that the main justification for the very large sample sizes in the decennial census and the OES is in the need for data for industries, and for states and smaller geographic areas, rather than to have very small sampling errors on national statistics.

5.1 Decennial Census

Information on occupation is requested on the census "long form." In the past few censuses, about 16 percent of all households received the long form. As mentioned earlier, the Census Bureau is considering moving towards continuous measurement of items like occupation and industry. This would consist of a sample of about several million households per year. If continuous measurement is used, it is not clear whether the long form would be eliminated in the year 2000 or whether continuous measurement would be started after the census is complete. For discussion purposes, we assume the long form is used in the year 2000 and that it is carried out on a 16 percent sample of the population. The census sample would thus consist of about 17,500,000 households having about 24,000,000 persons in the labor force.

It is clear from Exhibit 2 that the census sample would provide adequate precision on national statistics for virtually all occupations. However, the quality of state data would be poor for possibly 100 to 300 occupations. The problem will obviously be more severe in the small states than the large ones, and will be worse if characteristics of the persons in each occupation are desired than if only counts are needed. In particular, the unemployment rate in most occupations is likely to be in the range 5 to 10 percent. Even crude reliability on the rate requires a sample size of at least 25 unemployed persons, implying the sample size for the occupation of between 250 and 500 persons. At the national level, this will only occur for occupations having 1,500 to 3,000 persons. There are 30 to 60 occupations with fewer employed persons. When one looks at the analyses of state data, most states will only achieve such sample sizes for 200 to 250 occupations.

The minimum standard of 25 persons in the analytic cell referred to in the previous paragraph will provide a coefficient of variation of about 20 percent, implying a confidence interval of plus and minus 40 percent at the 95 percent confidence level. Having definitional equivalence between the census and the OES could still leave wide variation in the estimates in the two surveys for a large number of small occupations. (This is in addition to the differences likely to arise from measurement differences in household vs. business respondents.) It might be useful to consider whether it is worth putting much effort into attempting to achieve formal definitional equivalency in the two surveys for the 200 or so smallest occupations when statistics will inevitably differ widely because of sampling error and measurement problems.

At present, the census is the only source of household-reported occupation data with a sample large enough to provide state data for more than a handful of occupations. As has been pointed out in other papers, the census suffers from limitations, it gets outdated quickly, and analyses suffer accordingly. If continuous measurement is implemented by the Census Bureau, combining data for three years (as is done for OES) would produce a sample large enough to provide census-type analyses on a reasonably current basis.

5.2 CPS

The CPS is carried out monthly with about 60,000 households containing about 85,000 persons in the labor force (i.e., employed plus unemployed). Because of oversampling in small states, the effective sample size (that is, the size of an equal probability sample with the same precision) is smaller, probably about 50,000 households. Table A indicates that if a standard is established for a minimum of 25 sample cases per occupation for publication or analyses, then CPS could produce data for about 300 occupations. If the minimum is 100 cases, then the number of occupations is in the 150-200 range. The monthly labor force reports actually show data for around 50 occupation groups, so that a fairly conservative policy is followed by the Census Bureau.

As indicated earlier, the identical labor force and occupation and industry data are obtained monthly. However, because of the partial panel nature of the sample, most sample persons are kept in the survey for four months so that for reporting of occupation data, cumulating information over a year does not provide a sample that is 12 times as large as the monthly reports. The number of separate households over the course of a year is probably about 175,000. There are about 500 occupations that would provide at least 25 persons per occupation. If three-year averages are considered acceptable, a minimum of 25 persons would be available for about 650 occupations. The minimum of 25 persons is probably sufficient for statistics on the number of persons in each occupation although if one is interested in changes over time, quite large changes would be necessary to be detectable with samples of 25 persons. Furthermore, much larger samples are needed for data on the characteristics of persons in each occupation, e.g., unemployment rate, median income, etc. These are the statistics that cannot be produced by the OES, and the ability to provide them makes the CPS uniquely valuable. A minimum sample size of 100 to 250 per occupation is probably required for such characteristics of each occupation. About 300 to 450 occupations would supply this sample size with a three-year average. However, income is only obtained once a year on CPS and a three-year average only consists of about 150,000 households. This sample size will provide reasonable data on income distributions for about 150 to 250 occupations.

It was mentioned earlier that other Government surveys also collect information on occupation. These surveys provide useful information for specialized analyses, but their sample sizes are considerably smaller than the annual total from CPS. Considering the likely different emphases on occupation data in their interviews and the fact that their editing and data processing probably differs from CPS, we doubt that it is worth incurring the uncertainty in comparability for the moderate increase of sample size.

5.3 OES

The OES is the major resource for reasonably current data on the occupational distribution of employed persons. The sample size is 700,000 establishments containing tens of millions of employees over a three-year period. Furthermore, the sample is designed to produce reasonable precision for each SIC group, and thus improves the precision for those small occupations that are concentrated in a few industries. The sample is also specifically designed to produce state, and in some areas, substate data. From the point of view of costs, household surveys cannot compete with the data collection procedures used in the OES, and the OES will undoubtedly remain the main source of employment statistics for the indefinite future. The sample size provides data with adequate precision for all except a handful of small occupations. However, the smallest 20 or 30 occupations are dominated by ones defined in "other" subgroups such as "other plumbing and related," and "other service managers," which are subject to variable interpretation. We doubt that anyone would get very excited over poor reliability on such items.

As noted previously, comparability between establishment and household survey data will never be exact, regardless of the structure of the SOC, as a result of different perceptions of work by employers and employees. It is not clear whether adding a skill-based component to the definition of occupations will narrow or widen the difference.

ISSUES FOR CONSIDERATION

6. Method Issues for Future Research

In this section, we will discuss the implications of the above discussions for future research. In Section 6.1, data collection issues for household surveys are discussed. Section 6.2 discusses the implications for establishment surveys, while Section 6.3 discusses sampling issues.

6.1 Implications for Household Data Collection Methods

The existing household data collection systems are based on the respondent using an occupation name, either in response to an open-ended question or by classifying him/herself into an appropriate category. This reliance on the name is an outgrowth of the difficulties in training interviewers and/or developing forms to collect information on occupational duties. Switching to a skills-based SOC could rely on a similar type of classification principle by using the name of the occupation to convey the distinguishing activities associated with the job. Australia has adopted this approach when switching to a skills-based system. The questions included on the Australian Census and labor force surveys are very similar to those used on the CPS and U.S. Decennial Census. These questions rely heavily on a clear correspondence between the respondent's comprehension of the occupation name and the definition within the occupational system. As noted in Section 3.1, this results in relatively low validity and reliability when the data are needed at low levels of aggregation (e.g., three-digit Census codes). It is not clear what the impact of switching to a skills-based SOC would be. However, it seems doubtful substantial improvements in quality would be realized.

By revising the SOC in ways similar to those illustrated in Table 2, substantial improvements could be made to data collection systems. Greater reliance on educational and training requirements may reduce the need to collect as much idiosyncratic information on activities and duties as is needed with the present system. If this is true, then collecting occupation information would become easier, and as a result, be more accurate than is currently the case. The implementation of uniform criteria, such as education/training, should provide guidance to the interviewer/respondent on the type of information that needs to be collected. For example, rather than knowing that a truck driver uses an 18 wheel truck (e.g., *vis-à-vis* a van), it might be sufficient to know what type of training he/she has to do the job.

Whether one uses an approach like Australia and not change the questions at all or the items are changed to adapt to the new system, revision of the SOC should account for how respondents think and describe their work. Making distinctions within the system that cannot be made by respondents is not useful for household data collection. It may actually be counterproductive, if the inability to link respondent labels to the classification system results in gross classification errors (e.g., spanning major occupational groups). This concern is greatest, perhaps, when revising any household based system that is linked to the new SOC (e.g., Census Alphabetical Index). Given the problems that the current CPS/Census systems now have with collecting three-digit occupation codes, serious consideration should be given to developing the new system assuming a higher level of aggregation that is more consistent with how respondents describe their jobs. This would be done in conjunction with the job analyses completed when revising the SOC that reflects skills.

When considering research into collection of occupation information on a skills-based system, there are gradations that one can consider, depending on the constraints placed upon the instrument. In the following sections, two tracts of research are discussed. The first provides ideas on what might be done relative to the Decennial Census. The second provides ideas on what might be done on other surveys which have fewer constraints and can assume some level of computer assisted interviewing. It should be noted that this discussion makes a number of assumptions that may not accurately reflect the priorities and plans of the Standard Occupational Revision Policy Committee. Nonetheless, they seem worthwhile as the start of a discussion of collection issues related to future research for revising the SOC.

6.1.1 Decennial Census

As implied throughout, the Decennial Census is highly constrained with respect to the amount of information that can be added to the form. Given the lead time needed to get the census form approved by Congress and the stage of development that a revised SOC is currently in, it does not seem likely that new questions could be developed to accommodate a revised system. Even if new questions could be developed, it is not clear they could ever be added to the Census.

Under these constraints, research could concentrate on how well the current questions provide the requisite information. This follows the lead taken by Australia, which developed a skills-based system around what users seemed to want, as well as what respondents seem to be able to provide. In doing this, they found it sufficient to rely on the questions very similar to these used on the CPS.

This research could take several forms:

1. Apply the revised SOC classifications to data collected on Census field test instruments. Analyze these data with respect to (1) how consistent the classifications are with training/education information and (2) how often codes cannot be assigned with a high degree of certainty; and

2. Conduct a separate survey that includes the current questions, along with more detailed items. Respondents would be classified twice. Once with the current questions and a second time using the more detailed questions. This would provide some indication of how accurate the current questions perform.

There are clear advantages to not changing the questions on the Census. The most obvious is that it offers a clear way to bridge the switch between the old and new classification scheme (see Section 5). One natural avenue for study #2 would be to add the current questions to the research that is now being done in connection with revising the DOT (AIR, 1995). This instrument includes an extensive battery of items that collect very detailed information on duties, skills, work context and a number of other job/worker characteristics related to occupation.

6.1.2 CPS and Other Computer Assisted Interviews

On surveys where more time can be spent collecting occupation data, then questions should be developed that ask respondents more specifically about activities or distinguishing job attributes. The development of these questions would have to rely on the use of computer assisted interviewing in order to implement complex skip patterns within the questionnaire. One approach to this would rely on a combination of occupation name and more detailed probing (as guided by the branching patterns) in situations where the name is known to be unreliable. For example, this might involve:

1. Asking the respondent open-ended question on the type of work done;

2. Having the computer match the words used by the respondent to a database that links these words to a particular occupational category or group; and

3. For situations where the match is "uncertain" or for occupations that are ambiguous, insert appropriate probes to clarify the information.

The assumption is that the use of occupation name is, in many cases, an efficient method to collect activities and duties. In those situations where it can be misleading, the interviewer would need to probe for clarifying information. A simplified version of this system is being implemented by several federal government agencies, including the National Science Foundation (NSF) (Hardy, 1994). In this system, a database has been developed that link particular words and occupational codes. If a match is found, then the individual is automatically assigned a code and skipped out of the instrument. If the match is not entirely clear, the person is skipped to a set of detailed probes that are designed to clarify ambiguities in the description.

The database used in Step #2 would be similar to what is currently used by the Census Bureau to machine-code responses to the occupation questions. The Census Bureau database (Appel and Hellerman,

1983) was developed by associating the words used in verbatim responses to the open ended occupation questions with the occupational codes that were assigned at the time the survey was conducted. Words or strings of words were then linked to particular occupational categories with a certain probability. Words that were uniquely linked to an occupational category with a high probability are then used to automatically assign a code to a verbatim response.

A similar database for a revised SOC could be developed using the data that has been (or is currently being) collected as part of the CPS and/or Decennial Census. New codes corresponding to the revised SOC would be assigned to the verbatim responses. The database would assign probabilities to the matches between words or word strings to the revised coding system. Those words that are ambiguous (e.g., linked to more than one type of code) or represent occupations for which it is inherently difficult to collect information on activities or duties (e.g., supervisors) would be identified for follow-up probing. This probing could take several forms. One might be to provide a list of occupations from which the respondent could choose a particular category. This would rely on the respondent's ability to classify him/herself correctly. Another type of probe might specifically ask about relevant activities or, perhaps, educational/training requirements for the job.

The reliance on current surveys to develop this database restricts information in several important ways. First, it does not provide a way of validating the link between the words and the occupational categories. As mentioned above, there are very few, if any, studies that have collected independent measures of occupation to validate the accuracy of occupation information. Without knowing if a match between the word and the occupational category is correct, it is difficult to understand the tradeoffs between different matching criteria. Second, use of current surveys does not allow one to supplement the open ended questions that are currently being used with more direct questions on skill levels or other, more direct, activity questions that distinguish the columns in Table 2.

For these reasons, it would be preferable to prospectively develop a database that provides the links between the words and particular occupational groups. As part of this development process, it would be important to construct questions on skill levels and distinguishing activities. This research would include both formative evaluation (e.g., use of cognitive laboratories and other qualitative methods), as well as a series of field experiments that measured the relative accuracy of the information collected from the proposed questions. As part of the development process, it would be important to validate information as it is collected. This would done through detailed job analysis of the occupations of the subjects included in the study.

An alternative approach to relying on occupation name to classify the respondent, is to shift completely to using attributes to identify the job (Tonn, 1993). These attributes might include, for example, repetitiveness of the task, reading skills, computational skills, level of supervision. To some extent, the development of a skills-based SOC is a special instance of this approach. Jobs are characterized, in part, by the amount of "skill" required to complete the work. The advantage of an attribute approach is that it provides a theoretically based set of characteristics that can be used to not only analyze the labor market, but also to describe any particular occupation. It would move the system away from reliance on job titles by asking more specifically about a uniform set of skills and job duties.

This approach could not be implemented in the near future for several reasons. First, it is unlikely that a common set of job attributes could be arrived at which satisfy all consumers. Tonn (1993) points out at least four schemes that are consistent with different disciplines concerned with labor market activities (economic, cognitive psychology, industrial psychology and technology). Second, it is not clear whether the data could be collected on a survey. As the job attribute list grows, the number of questions that would have to be asked also grows (sometimes exponentially). This underscores the advantages and disadvantages of using job names as a way to classify occupation. In one sense, the use of occupation name is a problem because of the multiple meanings attached to it. On the other hand, it offers a shorthand way of including many of the criteria that define particular jobs.

6.2 Issues Related to Establishment Surveys

The data collection issues related to implementing a new SOC for an establishment survey, such as the OES, primarily revolve around the storage and retrieval of information from establishment records:

1. Do employers have occupation information that is consistent with a skills-based SOC?;

2. How is this information stored in the records?; and

3. How can the survey facilitate the retrieval of the information from the records?

The anecdotal information from the OCS staff indicates that the information is generally available, as long as one is concerned with using criteria such as education and training. However, this information may be stored in a relatively disaggregated form. Research into the new SOC will need to investigate these observations in more detail. Studies on the content and format of the records should be conducted to better understand how information will be retrieved when responding to the survey. As on the household side, this should not be a one-way process. Studying the company records should be done not only with an eye towards whether it is available to provide the information, but also with an eye towards modifying the SOC categories to conform to what respondents are able to provide.

The questionnaires used to collect this information are predominantly mail, self-administered instruments. As with a household survey, establishment surveys will also want to consider whether questionnaire items should explicitly include education/training criteria or rely on the job title and associated description to implicitly incorporate these criteria. Including specific education/training may provide the respondent with concrete guidance on what should be included in the category. Alternatively, these criteria may not be available to the person filling out the form. It may lead to confusion and, perhaps, non-response.

Investigating these three issues should include research that examines (1) the content and format of company records, (2) who generally fills out the survey, and (3) how respondents apply the survey definitions when taking information out of their records. If at all possible, it would important to include within this research the ability to validate information in order to assess whether the skills criteria is applied as intended.

6.3 Sampling Issues for Future Research

We assume that if any important revisions are made in the SOC, it will be necessary to carry out a link study to measure the effect of definitional changes so that historical comparisons can be made with the old statistical series. We discuss the sample sizes needed for such link studies, and possible vehicles for implementing them.

Link studies can be carried out in two ways. One method is to have two independent samples, using the old definition in one sample and the new definition in the other. The sampling errors on estimates of the differences between statistics utilizing the two definitions are quite high. The most efficient sample design for such a purpose is to have the same sample size in the two samples. When this is done, the standard error on the estimate of change in an occupation is approximately 40 percent greater than the standard error on the estimate for each of the separate samples. Very large samples will be necessary to produce data that would permit historical links for most of the occupations. The sampling errors need to be fairly small for a link study to indicate whether important changes over time are occurring in particular occupations (when definitions have changed). A sampling error of 10 percent would appear to be the maximum that can be tolerated; even that figure may be too high. This reliability could be achieved for almost all of the occupations if, during one cycle of the OES, half the sample used the old definition and half the new one. Similarly, if the sample in the next census were split in two, historical comparability for almost all occupations would be achieved. The CPS and other current surveys would be quite inadequate with a two independent sample approach.

The second method is to have a single sample in which each respondent is asked all of the questions necessary for both the old and new definitions. The occupation for each sample person is then determined under both definitions, and the totals compared. From the point of view of providing a link between the two definitions, this is a much more efficient system. The sampling error of the estimate of the difference between the two definitions is reduced by the amount of correlation between the two definitions. Except for occupations that have been radically revised, the correlations can be expected to be fairly high. Moderate size samples should provide adequate precision for most occupations.

The latter method is essentially the procedure used by the Census Bureau in the past. A subsample of persons in the preceding census was selected, the occupations reported by the respondents together with the descriptions of activities carried out in their jobs were then reexamined and coded according to the new classification. Tabulations of occupations under the old and new definitions were then prepared and provided the links.

If revisions are made in the classification of occupation, it would be desirable to have information on comparability at the time the census tabulations for the year 2000 become available. This would be possible if the linkage comes from an analysis of the 1990 Census, which implies that the new definition is based on data reported in the 1990 census. For example, if a skill-based classification is introduced, the skills are simply educational attainment, and the questions asked about occupation and work activities are the same as in the past, then the 1990 census could be recoded and comparability be determined. If skills are described differently or the questions are reworded, the 1990 census could not be used.

As an alternative, the questions needed for both types of coding could be put into the CPS and kept on for several years. The sample size would be sufficient for most occupations. However, there is considerable competition for space on the CPS questionnaire and how an expansion of questions on occupation would fit into priorities for the survey would have to be determined by BLS and Census.

The third alternative is to ask the two sets of questions in the next census or in a large subsample of the census. Space on the census questionnaire is even tighter than in CPS and we think the Census Bureau would have a difficult time with a request for expansion of questions on a particular subject. This issue should be explored relatively soon. Staff members of the Census Bureau have informed Westat that time is running out on possible changes in the questionnaire for the next census.

We assume it is not practical to ask respondents in the OES to report two sets of occupation data with two different definitions. For purposes of historical continuity, the OES would have to be divided into two random halves, with different questions asked in the two parts. This would reduce the sample size available for the new definition, but considering the large sample size in the OES, even half the sample would provide quite good data for almost all occupations.

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TABLES AND EXHIBITS

TABLE 1

Examples of Surveys that Collect Occupation Information by Type of Respondent and Type of Administration

TYPE OF ADMINISTRATION

	Self	**Interviewer**
Employer	*Occupational Employment Survey*	*Occupational Compensation Survey*
Job Incumbent	*Decennial Census*	*Current Population Survey*

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TABLE 2

PROTOTYPE SKILLS-BASED, JOB FAMILY MATRIX

Distinguishing Activity Preparation Level	02 Administrative and Finance Occs.	05 Natural & Applied Science Occs.	06 Health Service Occs.	07 Law, Social Science, & Soc. & Community Service Occs.	09 Education, Training, & Instruct. Occs.	10 Art, Culture & Recreation Occs.	12 Retail & Wholesale Sales Occs.	14 Protective Service Occs.	15 Personal & Commercial Service Occs	17 Craft Occs.	18 Trans. & Equipment Operation Occs.	19 Occs. Unique to AG., Forest & Fishing	20 Occs. Unique to Extractive Operations	21 Occs. Unique to Mfg., Process & Plant & Sys. Operation
	020 General, Administrative, & Financial Mgmt	050 Engineering & Natural Science Managers	060 Medicine & Health Service Managers	070 Public Administrators, Chief Executives, & Legislators	090 Education Administrators	100 Communications Managers	120 Marketing, Advertising & Sales Managers	140 Protective Service Managers	150 Service Managers	170 Construction Managers	180 Transportation Managers	190 Managers in Agricultural Services, Forestry & Fishing	200 Managers of Extractive Operations	210 Mgrs. in Mfg. Process., & Plant & Systems Operations
1	021 Prof Occs in Administration & Finance	051 Prof Occs. Related to Natural & Applied Science	061 Professional Health Service Occupations	071 Prof Occs. in Law, Social Science, & Social & Community Service	091 Prof. Occs. in Education, Training, & Instruction	101 Prof Occs. in Arts, Culture, & Recreation	121 Prof Occs in Sales & Advertising	141 Prof. Occs. in Protective Services	151 Prof Service Occs					
2	022 Skilled Occs. in Administration, Finance & Insurance	052 Technical Occs Related to Natural & Applied Science	062 Technical & Skilled Health Service Occs	072 Tech. Occs. in Law, Social Science & Social & Community Service	092 Paraprof. Occs in Education, Training, & Instruction	102 Tech Occs in Art, Culture & Recreation	122 Skilled Sales & Buying Occs.	142 Skilled Protective Service Occs.	152 Skilled Service Occs.	172 Skilled Craft Workers	182 Skilled Transportation & Equipment Oper. Occs	192 Skilled Occs in Agriculture Forestry, & Fishing	202 Skilled Extractive Occs	212 Skilled Occs. Unique to Mfg., Process., & Plant & Sys. Ops.
3	023 Clerical & Administrative Support Occs.		063 Assisting Occs. in Health Services		093 Assisting Occs. in Education, Training, & Instruction	103 Assisting Occs in Art, Culture, & Recreation	123 Intermediate Sales Occs.	143 Intermediate Protective Service Occs.	153 Intermediate Service Occs.	173 Intermediate Craft Occs.	183 Intermediate Transportation & Equipment Oper. Occs	193 Intermediate Occs. in Ag., Forestry, & Fishing	203 Intermediate Extractive Occs.	213 Intermediate Occs. Unique to Mfg., Process., & Sys. Operation
4						104 Elemental Occs. in Art Culture, & Recreation	124 Elemental Sales Occs.	144 Elemental Service Occs.	154 Elemental Service Occs	174 Craft Helpers, Construction Laborers	184 Elemental Transportation & Material Moving Occs.	194 Elemental Occs. in Agriculture, Forestry, & Fishing	204 Elemental Extractive Occs	214 Elemental Occs. Unique to Mfg., & Processing

This prototype draws upon work done in Canada relating to the development of their 1992 National Occupational Classification (NOC). Preparation levels are defined as requiring the following level of education and/or training.

Level 0 - Management education, training, or experience
Level 1 - University degree
Level 2 - Two to three years of post-secondary education, training, or specific experience; or two to four years apprenticeship.
Level 3 - High school degree preferred; up to two years of on-the-job training, specific work experience, or training courses.
Level 4 - High school degree not required; short work demonstration or on-the-job training.

EXHIBIT 1

Draft Versions of Training and Education Questions used to Develop a Prototype Occupational Information System

Training and Education

Questions in this subsection refer to learning or instruction acquired through secondary schools, vocational-technical schools, colleges, universities, certification programs, military training programs, practicums, and organization/association sponsored training programs. This does not include those programs where performing the work is the principle instructional technique (on-the-job training, apprenticeships, fellowships, and residency).

1. What level of formal education is required for entry into this job (✓ one)? Name the course major most relevant for the level of education that you check.

___ Less than a High School Diploma

___ High School Diploma (or High School Equivalence Certificate)

___ Post-Secondary Technical Degree ____________________ (Name required major)

___ Some College Courses

___ Associate's Degree
(or other 2 year degree) ____________________ (Name required major)

___ Bachelor's Degree ____________________ (Name required major)

___ Master's Degree ____________________ (Name required major)

___ Beyond a Master's Degree
(e.g.. Law, Doctoral, Medical)____________________ (Name required major)

Source: American Institutes of Research, 1995. Development of Prototype Occupational Information System "DRAFT" Report, Volume 2.

2. Below is a list of 15 subject areas that cover most of the courses that occur in high school, junior college, college undergraduate degree programs, and other training programs.

Instructions:

- Read each subject area title, the definition, and the example courses.
- Determine the highest level of education at which coursework in that subject area is required for entry into this job. Use the following scale:
  0 = not required
  1 = high school
  2 = post-secondary technical training
  3 = college
  4 = graduate school or other post undergraduate training
- Circle the most appropriate value.

#	Subject Area	Definition: Courses focus on ...	Example Courses	Highest level of education at which coursework in this subject area is required...
1.	Technical Vocational	non-business specific technical skills	Agriculture; Industrial Arts; Auto-Shop; Electronics	0 1 2 3 4
2.	Business Vocational	basic business skills	Word Processing; Filing; Book Keeping/Basic Accounting;	0 1 2 3 4
3.	English/language Arts	primarily on reading, interpretation, and writing	Reading; Literature; Composition; Journalism; Creative Writing	0 1 2 3 4
4.	Oral Communication	primarily on oral communication	Oral Communication; Speech; Interpersonal Communication	0 1 2 3 4
5.	Languages	reading, writing, and/or speaking languages other than English	French; Chinese; German; Japanese; Latin; Russian; Spanish;	0 1 2 3 4
6.	Basic Math	basic and applied math	General Math; Business Math	0 1 2 3 4
7.	Advanced Math	advanced topics in math	Algebra; Geometry; Calculus; Statistics	0 1 2 3 4
8.	Physical Science	the study of matter and or energy	Physics, Chemistry, Astronomy	0 1 2 3 4
9.	Computer Science	computers and their uses	Programming, Information Systems Management, Software Applications	0 1 2 3 4
10.	Biological Science	the study of life and living beings	Life Science; Biology; Anatomy; Physiology	0 1 2 3 4
11.	Applied Science	the application of Science	Engineering; Health; Medicine	0 1 2 3 4
12.	Social Science	the behavioral sciences	Social Studies; Economics; History; Psychology; Sociology	0 1 2 3 4
13	Arts	visual and performing arts	Arts & Crafts; Music; Painting; Sculpture; Theater; Voice	0 1 2 3 4
14	Humanities	cultural and philosophical aspects of humans	Minority Studies; Philosophy; Religion	0 1 2 3 4
15.	Physical Education	physical fitness and sports	Aerobics; Jogging; Weight Lifting; Specific Sports	0 1 2 3 4

EXHIBIT 2

Number of Employed Persons in Descending Order of Occupation Size, 1991-1993

Freqs in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
1	49011	SALESPERSONS, RETAIL	3,438,510	3,438,510	3.31	3.31
2	19005	GENERAL MANAGERS & TOP EXECUTIVES	2,868,700	6,307,210	2.76	6.07
3	55347	GENERAL OFFICE CLERKS	2,660,890	8,968,100	2.56	8.63
4	49023	CASHIERS	2,660,370	11,628,470	2.56	11.18
5	55108	SECRETARIES, EXCEPT LEGAL & MEDICAL	2,440,560	14,069,030	2.35	13.53
6	55338	BOOKKEEPING, ACCOUNTING & AUDITING CLERKS	1,812,510	15,881,540	1.74	15.27
7	67005	JANITORS & CLEANERS	1,806,380	17,687,920	1.74	17.01
8	32502	REGISTERED NURSES	1,764,950	19,452,870	1.70	18.71
9	65008	WAITERS & WAITRESSES	1,748,910	21,201,780	1.68	20.39
10	98999	OTHER HELPERS, LABORERS & MATERIAL MOVERS, HAND	1,357,500	22,559,280	1.31	21.70
11	31305	TEACHERS, ELEMENTARY SCHOOL	1,313,510	23,872,790	1.26	22.96
12	41002	FIRST LINE SUPERVISORS, SALES & RELATED	1,301,830	25,174,620	1.25	24.21
13	97102	TRUCK DRIVERS, HEAVY OR TRACTOR TRAILER	1,259,450	26,434,070	1.21	25.42
14	51002	FIRST LINE SUPERVISORS, CLERICAL & ADMINISTRATIVE	1,229,930	27,664,000	1.18	26.61
15	65038	FOOD PREPARATION WORKERS	1,194,610	28,858,610	1.15	27.76
16	31308	TEACHERS, SECONDARY SCHOOL	1,193,140	30,051,750	1.15	28.90
17	49998	SALESPERSONS, EXCEPT SCIENTIFIC & RETAIL	1,167,870	31,219,620	1.12	30.03
18	85132	MAINTENANCE REPAIRERS, GENERAL UTILITY	1,118,560	32,338,180	1.08	31.10
19	66008	NURSING AIDES, ORDERLIES & ATTENDANTS	1,117,980	33,456,160	1.08	32.18
20	65041	COMBINED FOOD PREPARATION & SERVICE WORKERS	1,116,790	34,572,950	1.07	33.25
21	49021	STOCK CLERKS, SALES FLOOR	1,088,520	35,661,470	1.05	34.30
22	93956	ASSEMBLERS/FABRICATORS EXCEPT MACHINE/ELECTRONIC/PRECISION	1,074,420	36,735,890	1.03	35.33
23	55305	RECEPTIONISTS & INFORMATION CLERKS	927,730	37,663,620	0.89	36.22
24	97105	TRUCK DRIVERS-LIGHT, INCLUDE DELIVERY/ROUTE WORKERS	884,040	38,547,660	0.85	37.07
25	63047	GUARDS & WATCH GUARDS	829,530	39,377,190	0.80	37.87
26	67002	MAIDS & HOUSEKEEPING CLEANERS	787,320	40,164,510	0.76	38.63
27	21114	ACCOUNTANTS & AUDITORS	756,180	40,920,690	0.73	39.36
28	13002	FINANCIAL MANAGERS	716,050	41,636,740	0.69	40.04
29	39999	OTHER PROFESSIONAL, PARAPROFESSIONAL/TECHNICIANS	693,950	42,330,690	0.67	40.71
30	98902	HAND PACKERS & PACKAGERS	688,930	43,019,620	0.66	41.37
31	19999	ALL OTHER MANAGERS & ADMINISTRATORS	671,530	43,691,150	0.65	42.02
32	58023	STOCK CLERKS, STOCKROOM, WAREHOUSE OR STORAGE YARD	667,220	44,358,370	0.64	42.66
33	32505	LICENSED PRACTICAL NURSES	643,570	45,001,940	0.62	43.28
34	59999	ALL OTHER CLERICAL & ADMINISTRATIVE SUPPORT	615,560	45,617,500	0.59	43.87
35	55307	TYPISTS, INCLUDING WORD PROCESSING	612,490	46,229,990	0.59	44.46
36	58028	TRAFFIC, SHIPPING, & RECEIVING CLERKS	609,880	46,839,870	0.59	45.05
37	87102	CARPENTERS	578,030	47,417,900	0.56	45.60
38	65026	COOKS, RESTAURANT	573,510	47,991,410	0.55	46.16
39	85302	AUTOMOTIVE MECHANICS	563,960	48,555,370	0.54	46.70
40	92717	SEWING MACHINE OPERATORS, GARMENT	562,980	49,118,350	0.54	47.24
41	53102	TELLERS	554,640	49,672,990	0.53	47.77
42	81000	FIRST LINE SUPERVISORS, PRODUCTION & OPERATING	539,380	50,212,370	0.52	48.29
43	65032	COOKS, FAST FOOD	531,200	50,743,570	0.51	48.80
44	21999	ALL OTHER MANAGEMENT SUPPORT	483,060	51,226,630	0.46	49.27
45	31521	TEACHER AIDES, PARAPROFESSIONAL	449,270	51,675,900	0.43	49.70
46	25105	COMPUTER PROGRAMMERS	448,190	52,124,090	0.43	50.13
47	87202	ELECTRICIANS	438,520	52,562,610	0.42	50.55
48	65014	DINING ROOM & CAFETERIA ATTENDANTS, BARTENDER HELP	434,670	52,997,280	0.42	50.97
49	13011	MARKETING/ADVERTISING/PUBLIC RELATIONS MANAGERS	432,250	53,429,530	0.42	51.39
50	97947	INDUSTRIAL TRUCK & TRACTOR OPERATORS	411,780	53,841,310	0.40	51.78
51	25102	SYSTEMS ANALYSTS	393,540	54,234,850	0.38	52.16
52	83005	PRODUCTION INSPECTORS, TEST/GRADE/SORT/SAMPLE/WEIGH	393,510	54,628,360	0.38	52.54
53	28108	LAWYERS	388,800	55,017,160	0.37	52.91
54	32102	PHYSICIANS & SURGEONS	386,180	55,403,340	0.37	53.28
55	49005	SALESPERSONS, SCIENTIFIC PRODUCTS & SERVICES	385,550	55,788,890	0.37	53.64

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
56	56017	DATA ENTRY KEYERS, EXCEPT COMPOSING	383,230	56,172,120	0.37	54.02
57	97111	BUS DRIVERS, SCHOOL	381,540	56,553,660	0.37	54.39
58	63014	POLICE PATROL OFFICERS	380,230	56,933,890	0.37	54.76
59	22126	ELECTRICAL & ELECTRONIC ENGINEERS	376,620	57,310,510	0.36	55.12
60	65028	COOKS, INSTITUTION OR CAFETERIA	375,820	57,686,330	0.36	55.48
61	65005	BARTENDERS	369,830	58,056,160	0.36	55.84
62	53123	ADJUSTMENT CLERKS	368,170	58,424,330	0.35	56.19
63	81002	FIRST LINE SUPERVISORS, MECHANICS/INSTALLERS/REPAIRERS	367,120	58,791,450	0.35	56.54
64	49999	ALL OTHER SALES & RELATED	357,680	59,149,130	0.34	56.89
65	31302	TEACHERS, PRESCHOOL & KINDERGARTEN	356,740	59,505,870	0.34	57.23
66	53905	TEACHERS' AIDES & ASSISTANTS, CLERICAL	355,580	59,861,450	0.34	57.57
67	65017	COUNTER ATTENDANTS, COFFEE SHOP, LUNCHROOM, CAFETERIA	355,360	60,216,810	0.34	57.91
68	66011	HOME HEALTH AIDES	351,600	60,568,410	0.34	58.25
69	13017	ENGINEERING, MATHEMATICAL & NATURAL SCIENCES MANAGERS	348,760	60,917,170	0.34	58.59
70	89108	MACHINISTS	343,780	61,260,950	0.33	58.92
71	31311	TEACHERS, SPECIAL EDUCATION	338,350	61,599,300	0.33	59.24
72	15026	FOOD SERVICE/LODGING MANAGERS	337,120	61,936,420	0.32	59.57
73	92974	PACKAGING & FILLING MACHINE OPERATORS	324,910	62,261,330	0.31	59.88
74	49017	COUNTER & RENTAL CLERKS	323,340	62,584,670	0.31	60.19
75	68005	HAIRDRESSERS, HAIRSTYLISTS & COSMETOLOGISTS	323,090	62,907,760	0.31	60.50
76	32999	OTHER HEALTH PROFESSIONALS, PARAPROFESSIONALS/TECHNICIANS	320,810	63,228,570	0.31	60.81
77	55344	BILLING, COST & RATE CLERKS	319,940	63,548,510	0.31	61.12
78	97117	DRIVER/SALES WORKERS	313,240	63,861,750	0.30	61.42
79	81005	FIRST LINE SUPERVISORS, TRADES & EXTRACTIVE	304,860	64,166,610	0.29	61.71
80	55323	ORDER CLERKS, MATERIALS, MERCHANDISE & SERVICE	300,200	64,466,810	0.29	62.00
81	15005	EDUCATION ADMINISTRATORS	298,680	64,765,490	0.29	62.29
82	92998	OTHER MACHINE OPERATORS, EXCEPT METAL/PLASTIC	298,380	65,063,870	0.29	62.58
83	22505	ELECTRICAL/ELECTRONIC TECHNICIANS & TECHNOLOGISTS	295,820	65,359,690	0.28	62.86
84	93999	OTHER HAND WORKERS, NEC	295,710	65,655,400	0.28	63.14
85	22199	ALL OTHER ENGINEERS	295,000	65,950,400	0.28	63.43
86	31299	OTHER POSTSECONDARY TEACHERS	291,800	66,242,200	0.28	63.71
87	79030	GARDENERS & GROUNDSKEEPERS	290,720	66,532,920	0.28	63.99
88	49014	SALESPERSONS, PARTS	287,910	66,820,830	0.28	64.27
89	22514	DRAFTERS	286,920	67,107,750	0.28	64.54
90	27305	SOCIAL WORKERS, EXCEPT MEDICAL & PSYCHIATRIC	283,120	67,390,870	0.27	64.81
91	55102	LEGAL SECRETARIES	279,920	67,670,790	0.27	65.08
92	31314	INSTRUCTORS, VOCATIONAL	275,320	67,946,110	0.26	65.35
93	87502	PLUMBERS, PIPEFITTERS & STEAMFITTERS	274,740	68,220,850	0.26	65.61
94	93914	WELDERS & CUTTERS	273,420	68,494,270	0.26	65.88
95	63017	CORRECTION OFFICERS & JAILERS	270,490	68,764,760	0.26	66.14
96	55321	FILE CLERKS	267,490	69,032,250	0.26	66.39
97	43002	SALES AGENTS, INSURANCE	261,480	69,293,730	0.25	66.64
98	31321	INSTRUCTORS & COACHES, SPORTS & PHYSICAL TRAINING	257,680	69,551,410	0.25	66.89
99	69999	ALL OTHER SERVICE WORKERS	256,830	69,808,240	0.25	67.14
100	68038	CHILD CARE WORKERS	255,020	70,063,260	0.25	67.38
101	21511	PERSONNEL, TRAINING & LABOR RELATIONS SPECIALISTS	250,610	70,313,870	0.24	67.63
102	13014	ADMINISTRATIVE MANAGERS	248,210	70,562,080	0.24	67.86
103	98502	MACHINE FEEDERS & OFFBEARERS	247,440	70,809,520	0.24	68.10
104	85311	BUS & TRUCK MECHANICS & DIESEL ENGINE SPECIALISTS	238,030	71,047,550	0.23	68.33
105	49026	NEWS, STREET VENDORS & PHONE SOLICITORS	235,370	71,282,920	0.23	68.56
106	85999	OTHER MECHANICS, INSTALLERS & REPAIRERS	233,570	71,516,490	0.22	68.78
107	85110	MACHINERY MAINTENANCE MECHANICS	231,680	71,748,170	0.22	69.00
108	68014	AMUSEMENT & RECREATION ATTENDANTS	230,650	71,978,820	0.22	69.23
109	22135	MECHANICAL ENGINEERS	228,850	72,207,670	0.22	69.45
110	56011	COMPUTER OPERATORS, EXCEPT PERIPHERIAL EQUIPMENT	226,240	72,433,910	0.22	69.66

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
111	58008	PRODUCTION, PLANNING & EXPEDITING CLERKS	225,790	72,659,700	0.22	69.88
112	57102	SWITCHBOARD OPERATORS	225,580	72,885,280	0.22	70.10
113	13008	PURCHASING MANAGERS	218,670	73,103,950	0.21	70.31
114	55105	MEDICAL SECRETARIES	217,720	73,321,670	0.21	70.52
115	53508	BILL & ACCOUNT COLLECTORS	217,060	73,538,730	0.21	70.73
116	87402	PAINTERS & PAPERHANGERS, CONSTRUCTION & MAINTENANCE	214,510	73,753,240	0.21	70.93
117	93905	ELECTRICAL & ELECTRONIC ASSEMBLERS	213,410	73,966,650	0.21	71.14
118	15014	INDUSTRIAL PRODUCTIONMANAGERS	211,670	74,178,320	0.20	71.34
119	22127	COMPUTER ENGINEERS	207,490	74,385,810	0.20	71.54
120	63008	FIRE FIGHTERS	207,030	74,592,840	0.20	71.74
121	98905	VEHICLE WASHERS & EQUIPMENT CLEANERS	200,700	74,793,540	0.19	71.93
122	31399	OTHER TEACHERS/INSTRUCTORS	200,630	74,994,170	0.19	72.13
123	21108	LOAN OFFICERS & COUNSELORS	200,060	75,194,230	0.19	72.32
124	66005	MEDICAL ASSISTANTS	198,090	75,392,320	0.19	72.51
125	27302	SOCIAL WORKERS, MEDICAL & PSYCHIATRIC	198,050	75,590,370	0.19	72.70
126	97805	SERVICE STATION ATTENDANTS	192,370	75,782,740	0.19	72.88
127	13005	PERSONNEL, TRAINING & LABOR RELATIONS MANAGERS	191,880	75,974,620	0.18	73.07
128	27311	RECREATION WORKERS	191,050	76,165,670	0.18	73.25
129	21199	OTHER FINANCIAL SPECIALISTS	186,660	76,352,330	0.18	73.43
130	85902	HEATING/AIR CONDITIONING/REFRIGERATION MECHANICS	185,130	76,537,460	0.18	73.61
131	58026	ORDER FILLERS, WHOLESALE & RETAIL SALES	184,950	76,722,410	0.18	73.79
132	22599	OTHER ENGINEERING & RELATED TECHNICIANS & TECHNOLOGISTS	184,400	76,906,810	0.18	73.97
133	65002	HOSTS & HOSTESSES, LOUNGE, RESTAURANTS & COFFEE SHOP	183,660	77,090,470	0.18	74.14
134	15017	CONSTRUCTION MANAGERS	181,850	77,272,320	0.17	74.32
135	83002	PRECISION INSPECTORS, TESTERS & GRADERS	180,220	77,452,540	0.17	74.49
136	92705	TEXTILE MACHINE OPERATORS, WIND/TWIST/KNIT/WEAVE/CUT	180,160	77,632,700	0.17	74.66
137	65035	COOKS, SHORT ORDER	179,970	77,812,670	0.17	74.84
138	53121	LOAN & CREDIT CLERKS	178,860	77,991,530	0.17	75.01
139	66002	DENTAL ASSISTANTS	178,100	78,169,630	0.17	75.18
140	21308	PURCHASING AGENTS	177,110	78,346,740	0.17	75.35
141	79855	GENERAL FARMWORKERS	175,290	78,522,030	0.17	75.52
142	43017	SALES AGENTS, BUSINESS SERVICES	174,830	78,696,860	0.17	75.69
143	43014	SALES AGENTS, SECURITIES/COMMODITIES/FINANCIAL SERVICE	172,720	78,869,580	0.17	75.85
144	21902	COST ESTIMATORS	169,010	79,038,590	0.16	76.02
145	53314	INSURANCE POLICY PROCESSING CLERKS	167,860	79,206,450	0.16	76.18
146	85702	TELEPHONE & CABLE TV INSTALLERS & REPAIRERS	165,800	79,372,250	0.16	76.34
147	98102	HELPERS, MECHANIC & REPAIRER	164,550	79,536,800	0.16	76.50
148	87711	HIGHWAY MAINTENANCE WORKERS	162,480	79,699,280	0.16	76.65
149	91321	MACHINE FORMING OPERATORS	160,710	79,859,990	0.15	76.81
150	65099	OTHER FOOD SERVICE WORKERS	160,220	80,020,210	0.15	76.96
151	22121	CIVIL ENGINEERS, INCLUDING TRAFFIC	159,520	80,179,730	0.15	77.11
152	15008	HEALTH SERVICES MANAGERS	158,680	80,338,410	0.15	77.27
153	89132	SHEET METAL WORKERS	158,050	80,496,460	0.15	77.42
154	21302	BUYERS, EXCEPT FARM PRODUCTS	157,380	80,653,840	0.15	77.57
155	98312	HELPERS, CARPENTERS	155,540	80,809,380	0.15	77.72
156	65023	BUTCHERS & MEAT CUTTERS	155,130	80,964,510	0.15	77.87
157	34038	DESIGNERS, EXCEPT INTERIOR	154,730	81,119,240	0.15	78.02
158	68035	PERSONAL AND HOME CARE AIDES	154,360	81,273,600	0.15	78.17
159	97108	BUS DRIVERS, EXCEPT SCHOOL	152,660	81,426,260	0.15	78.31
160	85305	AUTOMOTIVE BODY & RELATED REPAIRERS	152,420	81,578,680	0.15	78.46
161	27308	HUMAN SERVICES WORKERS	151,420	81,730,100	0.15	78.60
162	92726	LAUNDRY & DRYCLEANING OPERATORS, EXCEPT PRESSING	150,430	81,880,530	0.14	78.75
163	93114	ELECTRICAL/ELECTRONIC EQUIPMENT ASSEMBLERS, PRECISION	149,170	82,029,700	0.14	78.89
164	32902	MEDICAL & CLINICAL LABORATORY TECHNOLIGISTS	148,800	82,178,500	0.14	79.04
165	32517	PHARMACISTS	146,760	82,325,260	0.14	79.18

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
166	53302	INSURANCE ADJUSTERS, EXAMINERS & INVESTIGATORS	145,370	82,470,630	0.14	79.32
167	65021	BAKERS, BREAD & PASTRY	144,270	82,614,900	0.14	79.46
168	27307	RESIDENTIAL COUNSELORS	143,090	82,757,990	0.14	79.59
169	66099	OTHER HEALTH SERVICE	142,660	82,900,650	0.14	79.73
170	55341	PAYROLL & TIMEKEEPING CLERKS	142,240	83,042,890	0.14	79.87
171	15023	COMMUNICATIONS/TRANSPORTATION & UTILITIES MANAGERS	139,660	83,182,550	0.13	80.00
172	31514	VOCATION/EDUCATION COUNSELORS	138,790	83,321,340	0.13	80.14
173	61099	OTHER SERVICE SUPERVISORS	137,620	83,458,960	0.13	80.27
174	31117	GRADUATE ASSISTANTS, TEACHING	137,190	83,596,150	0.13	80.40
175	89102	TOOL & DIE MAKERS	135,410	83,731,560	0.13	80.53
176	58005	DISPATCHERS, EXCEPT POLICE, FIRE & AMBULANCE	135,060	83,866,620	0.13	80.66
177	53808	HOTEL DESK CLERKS	133,080	83,999,700	0.13	80.79
178	31502	LIBRARIANS, PROFESSIONAL	130,180	84,129,880	0.13	80.91
179	93938	MEAT, POULTRY & FISH CUTTERS & TRIMMERS, HAND	127,820	84,257,700	0.12	81.04
180	79014	GARDENERS & GROUNDSKEEPERS	127,660	84,385,360	0.12	81.16
181	55335	CUSTOMER SERVICE REPRESENTATIVES, UTILITIES	127,550	84,512,910	0.12	81.28
182	15011	PROPERTY/REAL ESTATE MANAGERS	126,700	84,639,610	0.12	81.40
183	97956	OPERATING ENGINEERS	125,240	84,764,850	0.12	81.52
184	92965	CRUSHING/GRINDING/MIXING/BLENDING MACHINE OPERATORS	124,650	84,889,500	0.12	81.64
185	81099	OTHER FIRST LINE SUPERVISORS, PRODUCT/CONSTRUCT/MAINTAIN	123,330	85,012,830	0.12	81.76
186	92721	SEWING MACHINE OPERATORS, NON-GARMENT	121,200	85,134,030	0.12	81.88
187	91905	PLASTIC MOLDING/CASTING MACHINE OPERATORS	120,650	85,254,680	0.12	81.99
188	34002	WRITERS & EDITORS	120,210	85,374,890	0.12	82.11
189	61008	HOUSEKEEPERS	119,140	85,494,030	0.11	82.22
190	32908	DENTAL HYGIENISTS	118,840	85,612,870	0.11	82.34
191	43023	SALES AGENTS, ADVERTISING	118,660	85,731,530	0.11	82.45
192	81017	FIRST LINE SUPERVISORS, HELPERS/LABORERS/MOVERS-HAND	116,540	85,848,070	0.11	82.57
193	63099	OTHER PROTECTIVE SERVICE	116,330	85,964,400	0.11	82.68
194	53805	RESERVATION & TRANSPORTATION TICKET AGENTS	116,180	86,080,580	0.11	82.79
195	53105	NEW ACCOUNTS CLERKS	114,920	86,195,500	0.11	82.90
196	91117	MACHINE TOOL CUTTING OPERATORS, METAL/PLASTIC	114,550	86,310,050	0.11	83.01
197	98705	REFUSE COLLECTORS	112,950	86,423,000	0.11	83.12
198	22128	INDUSTRIAL ENGINEERS, EXCEPT SAFTEY	109,710	86,532,710	0.11	83.22
199	97989	OTHER MATERIAL MOVING EQUIPMENT OPERATORS	109,300	86,642,010	0.11	83.33
200	85723	ELECTRICAL POWERLINE INSTALLERS & REPAIRERS	108,750	86,750,760	0.10	83.43
201	58099	OTHER MATERIAL RECORDING, SCHEDULING & DISTRIBUTING	107,210	86,857,970	0.10	83.54
202	81011	FIRST LINE SUPERVISORS, TRANSPORT/MOVING MACHINES	106,730	86,964,700	0.10	83.64
203	32508	EMERGENCY MEDICAL TECHNICIANS	106,380	87,071,080	0.10	83.74
204	31317	INSTRUCTORS, NON-VOCATIONAL	105,920	87,177,000	0.10	83.84
205	87311	CONCRETE & TERRAZZO FINISHERS	104,880	87,281,880	0.10	83.94
206	21911	COMPLIANCE OFFICERS, EXCEPT CONSTRUCTION	104,800	87,386,680	0.10	84.05
207	53902	LIBRARY ASSISTANTS & BOOKMOBILE DRIVERS	104,640	87,491,320	0.10	84.15
208	53311	INSURANCE CLAIMS CLERKS	104,190	87,595,510	0.10	84.25
209	28305	PARALEGAL PERSONNEL	102,900	87,698,410	0.10	84.34
210	55314	PERSONNEL CLERKS, EXCEPT PAYROLL & TIMEKEEPING	101,860	87,800,270	0.10	84.44
211	32905	MEDICAL & CLINICAL LABORATORY TECHNICIANS	100,600	87,900,870	0.10	84.54
212	34035	ARTISTS & RELATED WORKERS	100,220	88,001,090	0.10	84.64
213	43021	TRAVEL AGENTS	99,820	88,100,910	0.10	84.73
214	57311	MESSENGERS	99,150	88,200,060	0.10	84.83
215	24505	CHEMICAL TECHNICIANS & TECHNOLOGISTS, EXCEPT HEALTH	98,540	88,298,600	0.09	84.92
216	79058	LAWN MAINTENANCE WRK	98,030	88,396,630	0.09	85.02
217	57302	MAIL CLERKS, EXCEPT MACHINE OPERATORS	96,690	88,493,320	0.09	85.11
218	56002	OPERATORS, BILLING/POSTING/CALCULATING MACHINES	96,650	88,589,970	0.09	85.20
219	24105	CHEMISTS, EXCEPT BIOCHEMISTS	95,600	88,685,570	0.09	85.29
220	92543	PRINTING PRESS MACHINE OPERATORS	95,500	88,781,070	0.09	85.38

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
221	68026	FLIGHT ATTENDANTS	93,320	88,874,390	0.09	85.48
222	55302	STENOGRAPHERS	93,080	88,967,470	0.09	85.57
223	25108	COMPUTER PROGRAMMER AIDES	92,830	89,060,300	0.09	85.65
224	87999	OTHER CONSTRUCTION & EXTRACTIVE, EXCEPT HELPERS	91,500	89,151,800	0.09	85.74
225	32917	RADIOLOGIC TECHNOLOGISTS	91,100	89,242,900	0.09	85.83
226	65011	FOOD SERVERS, OUTSIDE	90,830	89,333,730	0.09	85.92
227	92997	OTHER MACHINE SETTERS, EXCEPT METAL/PALSTIC	90,780	89,424,510	0.09	86.00
228	21102	UNDERWRITERS	90,320	89,514,830	0.09	86.09
229	32308	PHYSICAL THERAPISTS	89,970	89,604,800	0.09	86.18
230	85323	AIRCRAFT MECHANICS	89,680	89,694,480	0.09	86.26
231	31210	SOCIAL SCIENCES TEACHERS	89,580	89,784,060	0.09	86.35
232	67099	OTHER CLEANING & BUILDING SERVICE WORKERS	89,380	89,873,440	0.09	86.44
233	53502	WELFARE ELIGIBILITY WORKERS & INTERVIEWERS	89,280	89,962,720	0.09	86.52
234	66014	PSYCHIATRIC AIDES	89,020	90,051,740	0.09	86.61
235	89311	CABINETMAKERS & BENCH CARPENTERS	87,940	90,139,680	0.08	86.69
236	79999	ALL OTHER AGRICULTURAL, FORESTRY & FISHING WORKERS	86,990	90,226,670	0.08	86.78
237	61005	POLICE & DETECTIVE SUPERVISORS	84,860	90,311,530	0.08	86.86
238	87808	ROOFERS	84,060	90,395,590	0.08	86.94
239	97899	ALL OTHER TRANSPORTATION & RELATED WORKERS	82,430	90,478,020	0.08	87.02
240	87302	BRICKMASONS	81,880	90,559,900	0.08	87.10
241	85953	TIRE REPAIRERS & CHANGERS	80,730	90,640,630	0.08	87.17
242	32105	DENTISTS	80,560	90,721,190	0.08	87.25
243	92728	PRESSING MACHINE OPERATORS, TEXTILE & GARMENT	79,840	90,801,030	0.08	87.33
244	85705	DATA PROCESSING EQUIPMENT REPAIRERES	79,520	90,880,550	0.08	87.41
245	97[illegible]38	GRADER, DOZER & SCRAPER OPERATORS	79,440	90,959,990	0.08	87.48
246	63[illegible]32	SHERIFFS & DEPUTY SHERIFFS	79,240	91,039,230	0.08	87.56
247	34008	PUBLIC RELATIONS SPECIALISTS & PUBLICITY WRITERS	78,850	91,118,080	0.08	87.63
248	95002	WATER/LIQUID WASTE TREATMENT PLANT & SYSTEM OPERATORS	78,790	91,196,870	0.08	87.71
249	31216	LANGUAGES TEACHERS	78,450	91,275,320	0.08	87.78
250	85314	MOBILE HEAVY EQUIPMENT MECHANICS, EXCEPT ENGINES	77,690	91,353,010	0.07	87.86
251	97702	AIRCRAFT PILOTS & FLIGHT ENGINEERS	77,680	91,430,690	0.07	87.93
252	79017	ANIMAL CARETAKERS	75,990	91,506,680	0.07	88.01
253	31202	LIFE SCIENCES TEACHERS	75,970	91,582,650	0.07	88.08
254	93935	CANNERY WORKERS	73,670	91,656,320	0.07	88.15
255	87708	PAVING, SURFACING & TAMPING EQUIPMENT OPERATORS	73,540	91,729,860	0.07	88.22
256	91502	NUMERICAL CONTROL MACHINE TOOL OPERATORS, METAL/PLASTIC	73,540	91,803,400	0.07	88.29
257	97923	EXCAVATING & LOADING MACHINE OPERATORS	73,440	91,876,840	0.07	88.36
258	92512	OFFSET LITHOGRAPHIC PRESS SETTERS	73,100	91,949,940	0.07	88.43
259	27108	PSYCHOLOGISTS	72,980	92,022,920	0.07	88.50
260	66017	PHYSICAL & CORRECTIVE THERAPY ASSISTANTS & AIDES	72,150	92,095,070	0.07	88.57
261	93953	GRINDING & POLISHING WORKERS, HAND	71,700	92,166,770	0.07	88.64
262	43008	SALES AGENTS, REAL ESTATE	71,610	92,238,380	0.07	88.71
263	85502	CENTRAL OFFICE & PBX INSTALLERS & REPAIRERS	71,290	92,309,670	0.07	88.78
264	32911	MEDICAL RECORDS TECHNICIANS	71,240	92,380,910	0.07	88.85
265	32302	RESPIRATORY THERAPISTS	70,850	92,451,760	0.07	88.92
266	58002	DISPATCHERS, POLICE, FIRE & AMBULANCE	70,240	92,522,000	0.07	88.98
267	32931	PSYCHIATRIC TECHNICIANS	70,070	92,592,070	0.07	89.05
268	22511	MECHANICAL TECHNICIANS & TECHNOLOGISTS	69,900	92,661,970	0.07	89.12
269	25199	OTHER COMPUTER SCIENTISTS & RELATED	69,660	92,731,630	0.07	89.19
270	91105	LATHE TOOL SETTERS	69,410	92,801,040	0.07	89.25
271	21508	INTERVIEWERS, EMPLOYMENT SERVICE	69,370	92,870,410	0.07	89.32
272	19002	CHIEF EXECUTIVES, LEGISLATORS & PUBLIC ADMINISTRATORS	69,280	92,939,690	0.07	89.39
273	32921	RADIOLOGIC TECHNICIANS	69,140	93,008,830	0.07	89.45
274	85123	MILLWRIGHTS	68,720	93,077,550	0.07	89.52
275	98311	HELPERS, BRICK & STONE MASONS, HARD TILE SETTERS	68,170	93,145,720	0.07	89.58

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
276	43099	OTHER SALES REPRESENTATIVES & SALESPERSONS, SERVICE	66,770	93,212,490	0.06	89.65
277	89999	OTHER PRECISION WORKERS, NEC	66,090	93,278,580	0.06	89.71
278	55332	INTERVIEWING CLERKS, EXCEPT PERSONNEL OR WELFARE	66,000	93,344,580	0.06	89.78
279	49002	SALES ENGINEERS	66,000	93,410,580	0.06	89.84
280	53128	BROKERAGE CLERKS	65,760	93,476,340	0.06	89.90
281	22502	CIVIL ENGINEERING TECHNICIANS & TECHNOLOGISTS	65,550	93,541,890	0.06	89.96
282	92953	COATING, PAINTING & SPRAYING MACHINE OPERATORS	65,440	93,607,330	0.06	90.03
283	32314	SPEECH PATHOLOGISTS & AUDIOLOGISTS	65,340	93,672,670	0.06	90.09
284	92198	ALL OTHER MACHINE OPERATORS, METAL/PLASTIC	64,700	93,737,370	0.06	90.15
285	92971	EXTRUDING/FORMING/PRESSING/COMPACTING MACHINE OPERATORS	63,380	93,800,750	0.06	90.21
286	92935	CHEMICAL EQUIPMENT CONTROLLERS & OPERATORS	63,330	93,864,080	0.06	90.27
287	98313	HELPERS, ELECTRICIANS & POWERLINE INSTALLERS	63,220	93,927,300	0.06	90.34
288	98315	HELPERS, PLUMBERS/PIPEFITTERS/STEAMFITTERS	62,950	93,990,250	0.06	90.40
289	24308	BIOLOGICAL SCIENTISTS	62,190	94,052,440	0.06	90.46
290	31505	TECHNICAL ASSISTANTS, LIBRARY	62,180	94,114,620	0.06	90.52
291	21111	TAX PREPARERS	62,120	94,176,740	0.06	90.58
292	49032	DEMONSTRATORS, PROMOTERS & MODELS	61,930	94,238,670	0.06	90.64
293	79005	NURSERY WORKERS	61,520	94,300,190	0.06	90.69
294	79011	GRADERS & SORTERS, AGRICULTURAL PRODUCTS	61,060	94,361,250	0.06	90.75
295	21905	MANAGEMENT ANALYSTS	61,030	94,422,280	0.06	90.81
296	22302	ARCHITECTS, EXCEPT LANDSCAPE & MARINE	60,070	94,482,350	0.06	90.87
297	89802	SLAUGHTERERS & BUTCHERS	60,020	94,542,370	0.06	90.93
298	87899	ALL OTHER CONSTRUCTION TRADES	59,760	94,602,130	0.06	90.98
299	34056	PRODUCERS, DIRECTORS, ACTORS & OTHER ENTERTAINERS	59,020	94,661,150	0.06	91.04
300	56099	OTHER OFFICE MACHINE OPERATORS	58,350	94,719,500	0.06	91.10
301	91114	GRINDING, LAPPING & BUFFING MACHINE OPERATORS	58,260	94,777,760	0.06	91.15
302	21908	CONSTRUCTION & BUILDING INSPECTORS	57,900	94,835,660	0.06	91.21
303	32514	OPTICIANS	57,800	94,893,460	0.06	91.26
304	92944	CUTTING & SLICING MACHINE OPERATORS	57,620	94,951,080	0.06	91.32
305	31517	INSTRUCTIONAL COORDINATORS	57,120	95,008,200	0.05	91.38
306	85118	MACHINERY MAINTENANCE MECHANICS, WATER/POWER PLANT	57,110	95,065,310	0.05	91.43
307	85926	OFFICE MACHINE & CASH REGISTER SERVICERS	57,050	95,122,360	0.05	91.48
308	93105	MACHINE BUILDERS & OTHER PRECISION MACHINE ASSEMBLERS	57,030	95,179,390	0.05	91.54
309	97114	TAXI DRIVERS & CHAUFFEURS	56,920	95,236,310	0.05	91.59
310	31218	ART, DRAMA & MUSIC TEACHERS	55,250	95,291,560	0.05	91.65
311	63044	CROSSING GUARDS	55,010	95,346,570	0.05	91.70
312	22102	AERONAUTICAL & ASTRONAUTICALENGINEERS	54,840	95,401,410	0.05	91.75
313	61002	FIRE FIGHTING & PREVENTION SUPERVISORS	54,620	95,456,030	0.05	91.81
314	97808	PARKING LOT ATTENDANTS	54,600	95,510,630	0.05	91.86
315	55328	STATISTICAL CLERKS	54,210	95,564,840	0.05	91.91
316	87802	INSULATION WORKERS	54,200	95,619,040	0.05	91.96
317	22114	CHEMICAL ENGINEERS	53,930	95,672,970	0.05	92.01
318	34023	PHOTOGRAPHERS	53,910	95,726,880	0.05	92.07
319	85128	MACHINERY MAINTENANCE WORKERS	53,690	95,780,570	0.05	92.12
320	32518	PHARMACY TECHNICIANS	53,310	95,833,880	0.05	92.17
321	21921	CLAIMS EXAMINERS	53,270	95,887,150	0.05	92.22
322	66026	PHARMACY ASSISTANTS	53,010	95,940,160	0.05	92.27
323	21117	BUDGET ANALYSTS	52,190	95,992,350	0.05	92.32
324	91705	WELDING MACHINE OPERATORS	52,010	96,044,360	0.05	92.37
325	92197	ALL OTHER MACHINE SETTERS, METAL/PLASTIC	51,560	96,095,920	0.05	92.42
326	91305	PRESS & PRESS BRAKE MACHINE SETTERS, METAL/PLASTIC	51,420	96,147,340	0.05	92.47
327	34011	REPORTERS & CORRESPONDENTS	51,380	96,198,720	0.05	92.52
328	55326	PROCUREMENT CLERKS	51,200	96,249,920	0.05	92.57
329	63011	POLICE DETECTIVES	51,040	96,300,960	0.05	92.62
330	68021	USHERS, LOBBY ATTENDANTS & TICKET TAKERS	50,990	96,351,950	0.05	92.67

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
331	91505	COMBINATION MACHINE TOOL SETTERS, METAL/PLASTIC	50,790	96,402,740	0.05	92.72
332	85119	OTHER MACHINERY MAINTENANCE MECHANICS	50,230	96,452,970	0.05	92.76
333	93926	CUTTERS & TRIMMERS, HAND	50,230	96,503,200	0.05	92.81
334	92914	PAPER GOODS MACHINE SETTERS	49,810	96,553,010	0.05	92.86
335	32511	PHYSICIAN'S ASSISTANTS	49,490	96,602,500	0.05	92.91
336	85711	ELECTRIC HOME APPLIANCE & POWER TOOL REPAIRERS	49,220	96,651,720	0.05	92.96
337	93902	MACHINE ASSEMBLERS	49,070	96,700,790	0.05	93.00
338	57108	CENTRAL OFFICE OPERATORS	48,620	96,749,410	0.05	93.05
339	34017	ANNOUNCERS, RADIO/TELEVISION	48,570	96,797,980	0.05	93.10
340	58014	METER READERS, UTILITIES	48,020	96,846,000	0.05	93.14
341	97951	CONVEYOR OPERATORS & TENDERS	48,020	96,894,020	0.05	93.19
342	93111	ELECTROMECHANICAL EQUIPMENT ASSEMBLERS, PRECISION	47,770	96,941,790	0.05	93.23
343	98319	HELPERS, OTHER CONSTRUCTION TRADES	47,700	96,989,490	0.05	93.28
344	53702	COURT CLERKS	47,460	97,036,950	0.05	93.33
345	67008	PEST CONTROLLERS & ASSISTANTS	47,450	97,084,400	0.05	93.37
346	22521	SURVEYING & MAPPING TECHNICIANS & TECHNOLOGISTS	47,230	97,131,630	0.05	93.42
347	34051	MUSICIANS, INSTRUMENTAL	47,140	97,178,770	0.05	93.46
348	87108	DRYWALL INSTALLERS	47,080	97,225,850	0.05	93.51
349	91508	COMBINATION MACHINE TOOL OPERATORS, METAL/PLASTIC	46,940	97,272,790	0.05	93.55
350	87508	PIPELAYERS	46,890	97,319,680	0.05	93.60
351	56008	MAIL MACHINE OPERATORS, PREPARATION & HANDLING	46,630	97,366,310	0.04	93.64
352	31114	NURSING INSTRUCTORS	46,430	97,412,740	0.04	93.69
353	89308	WOOD MACHINISTS	46,420	97,459,160	0.04	93.73
354	91702	WELDING MACHINE SETTERS	46,050	97,505,210	0.04	93.78
355	34044	MERCHANDISE DISPLAYERS & WINDOW TRIMMERS	45,870	97,551,080	0.04	93.82
356	91302	PUNCHING MACHINE SETTERS, OPERATORS, METAL/PLASTIC	45,200	97,596,280	0.04	93.86
357	32928	SURGICAL TECHNICIANS	45,070	97,641,350	0.04	93.91
358	24199	ALL OTHER PHYSICAL SCIENTISTS	44,150	97,685,500	0.04	93.95
359	91108	DRILLING/BORING MACHINE TOOL SETTERS, METAL/PLASTIC	43,530	97,729,030	0.04	93.99
360	89505	CUSTOM TAILORS & SEWERS	42,560	97,771,590	0.04	94.03
361	63035	DETECTIVES & INVESTIGATORS, EXCEPT PUBLIC	42,420	97,814,010	0.04	94.07
362	83099	OTHER INSPECTORS, TESTERS & RELATED WORKERS	41,850	97,855,860	0.04	94.11
363	58011	TRANSPORTATION AGENTS	41,780	97,897,640	0.04	94.15
364	87814	STRUCTURAL METAL WORKERS	41,780	97,939,420	0.04	94.19
365	93197	OTHER PRECISION ASSEMBLERS	41,510	97,980,930	0.04	94.23
366	85905	PRECISION INSTRUMENT REPAIRERS	41,500	98,022,430	0.04	94.27
367	25302	SYSTEMS RESEARCHERS	41,270	98,063,700	0.04	94.31
368	92908	PHOTOGRAPHIC PROCESSING MACHINE OPERATORS	41,140	98,104,840	0.04	94.35
369	92308	SAWING MACHINE OPERATORS	40,870	98,145,710	0.04	94.39
370	92951	COATING, PAINTING & SPRAYING MACHINE SETTERS	40,800	98,186,510	0.04	94.43
371	92546	BINDERY MACHINE OPERATORS	40,380	98,226,890	0.04	94.47
372	32521	DIETITIANS & NUTRITIONISTS	40,140	98,267,030	0.04	94.51
373	85726	STATION INSTALLERS & REPAIRERS, TELEPHONE	40,130	98,307,160	0.04	94.55
374	95008	CHEMICAL PLANT & SYSTEM OPERATORS	39,710	98,346,870	0.04	94.59
375	95099	OTHER PLANT & SYSTEM OPERATORS	39,630	98,386,500	0.04	94.62
376	85717	ELECTRONICS REPAIRERS, COMMERCIAL/INDUSTRY EQUIPMENT	39,420	98,425,920	0.04	94.66
377	89508	UPHOLSTERERS	39,180	98,465,100	0.04	94.70
378	31212	HEALTH SPECIALTIES TEACHERS	39,000	98,504,100	0.04	94.74
379	97944	CRANE & TOWER OPERATORS	38,810	98,542,910	0.04	94.77
380	53117	CREDIT CHECKERS	38,720	98,581,630	0.04	94.81
381	91311	EXTRUDING/DRAWING MACHINE SETTERS, METAL/PLASTIC	38,610	98,620,240	0.04	94.85
382	31224	MATHEMATICAL SCIENCE TEACHERS	38,480	98,658,720	0.04	94.89
383	89921	PRECISION DENTAL LABORATORY TECHNICIANS	37,950	98,696,670	0.04	94.92
384	32305	OCCUPATIONAL THERAPISTS	37,940	98,734,610	0.04	94.96
385	85799	OTHER ELECTRICAL/ELECTRONIC EQUIPMENT MECHANIC/INSTALL	37,740	98,772,350	0.04	95.00

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
386	87805	SHEET METAL DUCT INSTALLERS	37,640	98,809,990	0.04	95.03
387	24599	OTHER PHYSICAL & LIFE SCIENCE TECHNICIANS & TECHNOLOGISTS	37,460	98,847,450	0.04	95.07
388	97317	RAILROAD BRAKE, SIGNAL & SWITCH OPERATORS	37,330	98,884,780	0.04	95.10
389	89111	TOOL GRINDERS, FILERS & SHARPENERS	37,260	98,922,040	0.04	95.14
390	85321	FARM EQUIPMENT MECHANICS	37,120	98,959,160	0.04	95.17
391	92702	TEXTILE MACHINE SETTERS	35,810	98,994,970	0.03	95.21
392	21105	CREDIT ANALYSTS	35,800	99,030,770	0.03	95.24
393	92314	WOODWORKING MACHINE OPERATORS, EXECPT SAWING	35,770	99,066,540	0.03	95.28
394	89805	BAKERS, MANUFACTURING	35,110	99,101,650	0.03	95.31
395	58017	WEIGHERS, MEASURERS, CHECKERS & SAMPLERS, RECORDKEEPING	35,050	99,136,700	0.03	95.35
396	34005	TECHNICAL WRITERS	34,980	99,171,680	0.03	95.38
397	31222	ENGINEERING TEACHERS	34,700	99,206,380	0.03	95.41
398	92947	PAINTERS, TRANSPORTATION EQUIPMENT	34,610	99,240,990	0.03	95.45
399	43011	APPRAISERS, REAL ESTATE	34,470	99,275,460	0.03	95.48
400	34028	BROADCAST TECHNICIANS	33,270	99,308,730	0.03	95.51
401	58021	MARKING CLERKS	33,210	99,341,940	0.03	95.54
402	91714	METAL FABRICATORS, STRUCTURAL METAL PRODUCTS	33,030	99,374,970	0.03	95.57
403	21914	TAX EXAMINERS, COLLECTORS & REVENUE AGENTS	32,990	99,407,960	0.03	95.61
404	22311	SURVEYING & MAPPING SCIENTISTS	32,900	99,440,860	0.03	95.64
405	68023	BAGGAGE PORTERS & BELLHOPS	32,840	99,473,700	0.03	95.67
406	28399	OTHER LEGAL ASSISTANTS & TECHNICIANS	32,690	99,506,390	0.03	95.70
407	24502	BIOLOGICAL/AGRICULTURAL/FOOD TECHNICIANS & TECHNOLOGISTS	32,660	99,539,050	0.03	95.73
408	91902	PLASTIC MOLDING/CASTING MACHINE SETTERS & OPERATORS	32,010	99,571,060	0.03	95.76
409	97302	RAILROAD CONDUCTORS & YARDMASTERS	31,090	99,602,150	0.03	95.79
410	87811	GLAZIERS	31,000	99,633,150	0.03	95.82
411	56005	DUPLICATING MACHINE OPERATORS	30,940	99,664,090	0.03	95.85
412	34041	INTERIOR DESIGNERS	30,920	99,695,010	0.03	95.88
413	89717	STRIPPERS	30,330	99,725,340	0.03	95.91
414	55317	CORRESPONDENCE CLERKS	30,000	99,755,340	0.03	95.94
415	25315	FINANCIAL ANALYSTS, STATISTICAL	29,960	99,785,300	0.03	95.97
416	97199	OTHER MOTOR VEHICLE OPERATORS	29,890	99,815,190	0.03	96.00
417	92902	ELECTRONIC SEMICONDUCTOR PROCESSORS	29,670	99,844,860	0.03	96.03
418	28302	LAW CLERKS	29,540	99,874,400	0.03	96.06
419	27199	ALL OTHER SOCIAL SCIENTISTS	28,380	99,902,780	0.03	96.08
420	24111	GEOLOGISTS, GEOPHYSICISTS & OCEANOGRAPHERS	28,220	99,931,000	0.03	96.11
421	92525	BINDERY MACHINE SETTERS	28,130	99,959,130	0.03	96.14
422	92941	CUTTING & SLICING MACHINE SETTERS	28,020	99,987,150	0.03	96.16
423	72002	FIRST LINE SUPERVISORS, AGRICULTURAL/FORESTRY/FISHING	27,980	100,015,130	0.03	96.19
424	87921	ROUSTABOUTS	27,940	100,043,070	0.03	96.22
425	92714	TEXTILE BLEACHING & DYEING MACHINE OPERATORS	27,830	100,070,900	0.03	96.24
426	79806	VET ASSISTANTS	27,680	100,098,580	0.03	96.27
427	57105	DIRECTORY ASSISTANCE OPERATORS	27,270	100,125,850	0.03	96.30
428	56014	PERIPHERAL EDP EQUIPMENT OPERATORS	27,150	100,153,000	0.03	96.32
429	89808	FOOD BATCHMAKERS	26,880	100,179,880	0.03	96.35
430	32114	VETERINARIANS & VETERINARY INSPECTORS	26,690	100,206,570	0.03	96.37
431	92923	FURNACE, KILN, OVEN, DRIER, OR KETTLE OPERATORS	26,650	100,233,220	0.03	96.40
432	79033	PRUNERS	26,340	100,259,560	0.03	96.43
433	95032	STATIONARY ENGINEERS	26,240	100,285,800	0.03	96.45
434	93102	AIRCRAFT STRUCTURE/SURFACES/RIGGING/SYSTEMS ASSEMBLERS	25,900	100,311,700	0.02	96.48
435	92956	CEMENTING & GLUING MACHINE OPERATORS	25,890	100,337,590	0.02	96.50
436	89517	PRESSERS, DELICATE FABRICS	25,840	100,363,430	0.02	96.53
437	85708	ELECTRONIC HOME ENTERTAINMENT EQUIPMENT REPARIERS	25,720	100,389,150	0.02	96.55
438	32317	RECREATIONAL THERAPISTS	25,710	100,414,860	0.02	96.58
439	85112	MACHINERY MAINTENANCE MECHANICS, TEXTILE MACHINES	25,700	100,440,560	0.02	96.60
440	27105	URBAN & REGIONAL PLANNERS	25,510	100,466,070	0.02	96.62

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
441	43005	BROKERS, REAL ESTATE	25,450	100,491,520	0.02	96.65
442	98702	STEVEDORES, EXCEPT EQUIPMENT OPERATORS	25,420	100,516,940	0.02	96.67
443	92968	EXTRUDING/FORMING/PRESSING/COMPACTING MACHINE SETTERS	25,200	100,542,140	0.02	96.70
444	92524	SCREEN PRINTING MACHINE SETTERS	25,190	100,567,330	0.02	96.72
445	97999	OTHER TRANSPORTATION, MATERIAL MOVING EQUIPMENT	24,970	100,592,300	0.02	96.75
446	27102	ECONOMISTS, INCLUDING MARKET RESEARCHERS	24,960	100,617,260	0.02	96.77
447	93947	PAINTING, COATING & DECORATING WORKERS, HAND	24,730	100,641,990	0.02	96.79
448	85328	SMALL ENGINE SPECIALISTS	24,540	100,666,530	0.02	96.82
449	89314	FURNITURE FINISHERS	24,350	100,690,880	0.02	96.84
450	91921	ELECTROLYTIC PLATING & COATING MACHINE OPERATORS	24,330	100,715,210	0.02	96.86
451	91111	MILLING & PLANING MACHINE SETTERS, METAL/PLASTIC	24,170	100,739,380	0.02	96.89
452	28102	JUDGES & MAGISTRATES	24,160	100,763,540	0.02	96.91
453	93917	SOLDERERS & BRAZERS	23,810	100,787,350	0.02	96.93
454	68008	MANICURISTS	23,750	100,811,100	0.02	96.96
455	22508	INDUSTRIAL TECHNICIANS & TECHNOLOGISTS	23,720	100,834,820	0.02	96.98
456	53126	STATEMENT CLERKS	23,670	100,858,490	0.02	97.00
457	87111	TAPERS	23,070	100,881,560	0.02	97.02
458	98316	HELPERS, ROOFERS	22,870	100,904,430	0.02	97.05
459	85317	RAIL CAR REPAIRERS	22,830	100,927,260	0.02	97.07
460	92708	EXTRUDING/FORMING MACHINE OPERATORS, SYNTHETIC/GLASS	22,830	100,950,090	0.02	97.09
461	98314	HELPERS, PAINTERS/PLASTERERS/STUCCO MASONS/PAPERHANGERS	22,650	100,972,740	0.02	97.11
462	92958	CLEANING, WASHING & PICKLING EQUIPMENT OPERATORS	22,630	100,995,370	0.02	97.13
463	24399	ALL OTHER LIFE SCIENTISTS	22,530	101,017,900	0.02	97.15
464	24311	MEDICAL SCIENTISTS	22,440	101,040,340	0.02	97.18
465	39011	FUNERAL DIRECTORS/MORTICIANS	22,300	101,062,640	0.02	97.20
466	87602	CARPET INSTALLERS	22,300	101,084,940	0.02	97.22
467	89706	PASTE-UP WORKERS	22,000	101,106,940	0.02	97.24
468	53914	REAL ESTATE CLERKS	21,910	101,128,850	0.02	97.26
469	95021	POWER PLANT OPERATORS, EXCEPT AUXILIARY EQUIPMENT	21,900	101,150,750	0.02	97.28
470	21917	ASSESSORS	21,820	101,172,570	0.02	97.30
471	53911	PROOFREADERS & COPY MARKERS	21,770	101,194,340	0.02	97.32
472	21305	BUYERS, FARM PRODUCTS	21,640	101,215,980	0.02	97.35
473	21505	SPECIAL AGENTS, INSURANCE	21,390	101,237,370	0.02	97.37
474	31226	COMPUTER SCIENCE TEACHERS	21,310	101,258,680	0.02	97.39
475	32523	DIETETIC TECHNICIANS	21,030	101,279,710	0.02	97.41
476	53705	MUNICIPAL CLERKS	20,910	101,300,620	0.02	97.43
477	93908	COIL WINDERS, TAPERS & FINISHERS	20,620	101,321,240	0.02	97.45
478	97305	LOCOMOTIVE ENGINEERS	20,490	101,341,730	0.02	97.47
479	92962	SEPARATING, FILTERING & STILL MACHINE OPERATORS	20,380	101,362,110	0.02	97.49
480	87317	PLASTERERS & STUCCO MASONS	20,270	101,382,380	0.02	97.51
481	87917	SERVICE UNIT OPERATORS	20,180	101,402,560	0.02	97.52
482	97314	SUBWAY & STREETCAR OPERATORS	19,970	101,422,530	0.02	97.54
483	87714	RAIL-TRACK LAYING/MAINTENANCE EQUIPMENT OPERATORS	19,930	101,442,460	0.02	97.56
484	91308	SHEAR & SLITTER MACHINE SETTERS, METAL/PLASTIC	19,900	101,462,360	0.02	97.58
485	91935	FURNACE OPERATORS	19,880	101,482,240	0.02	97.60
486	22132	SAFETY ENGINEERS, EXCEPT MINING	19,650	101,501,890	0.02	97.62
487	73011	LOGGING TRACTOR OPERATORS	19,490	101,521,380	0.02	97.64
488	91908	METAL MOLDING, COREMAKING & CASTING MACHINE SETTERS	19,400	101,540,780	0.02	97.66
489	85928	MECHANICAL CONTROL & VALVE INSTALLERS & REPAIRERS	19,310	101,560,090	0.02	97.68
490	92541	TYPESETTING & COMPOSING MACHINE OPERATORS	19,310	101,579,400	0.02	97.70
491	92311	WOODWORKING MACHINE SETTERS	19,050	101,598,450	0.02	97.71
492	32951	VET TECH & TECH	18,750	101,617,200	0.02	97.73
493	91911	METAL MOLDING, COREMAKING & CASTING MACHINE OPERATORS	18,730	101,635,930	0.02	97.75
494	53114	CREDIT AUTHORIZERS	18,540	101,654,470	0.02	97.77
495	89511	SHOE & LEATHER WORKERS & REPAIRERS, PRECISION	18,530	101,673,000	0.02	97.79

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
496	56021	DATA KEYERS, COMPOSING	18,510	101,691,510	0.02	97.80
497	89502	FABRIC/APPAREL PATTERNMAKERS & LAYOUT WORKERS	18,500	101,710,010	0.02	97.82
498	32108	OPTOMETRISTS	18,440	101,728,450	0.02	97.84
499	89123	JEWELERS & SILVERSMITHS	18,340	101,746,790	0.02	97.86
500	91952	HEATING/ANNEALING/TEMPERING MACHINE OPERATORS	18,300	101,765,090	0.02	97.87
501	89135	BOILERMAKERS	18,280	101,783,370	0.02	97.89
502	85947	COIN & VENDING MACHINE SERVICERS & REPAIRERS	18,060	101,801,430	0.02	97.91
503	87989	OTHER EXTRACTIVE WORKERS, EXCEPT HELPERS	18,010	101,819,440	0.02	97.93
504	28105	ADJUDICATORS, HEARINGS OFFICERS & JUCICIAL REVIEWERS	17,810	101,837,250	0.02	97.94
505	85728	ELECTRICAL INSTALL/REPAIR, TRANSPORTATION EQUIPMENT	17,810	101,855,060	0.02	97.96
506	89707	ELECTRONIC PAGINATION SYSTEM OPERATORS	17,790	101,872,850	0.02	97.98
507	53708	LICENSE CLERKS	17,780	101,890,630	0.02	97.99
508	85714	ELECTRIC MOTOR, TRANSFORMER & RELATED REPAIRERS	17,750	101,908,380	0.02	98.01
509	92549	OTHER PRINTING & BINDING MACHINE OPERATORS	17,710	101,926,090	0.02	98.03
510	27599	ALL OTHER RELIGIOUS WORKERS	17,510	101,943,600	0.02	98.05
511	92986	BOILER OPERATORS, LOW PRESSURE	17,500	101,961,100	0.02	98.06
512	93921	PRESSERS, HAND	16,940	101,978,040	0.02	98.08
513	53908	ADVERTISING CLERKS	16,890	101,994,930	0.02	98.09
514	87817	FENCE ERECTORS	16,650	102,011,580	0.02	98.11
515	68041	FUNERAL ATTENDANTS	16,460	102,028,040	0.02	98.13
516	22105	METALLURGISTS/METALLURGICAL, CERAMIC & MATERIALS ENGINEERS	16,310	102,044,350	0.02	98.14
517	85958	INSTALLERS & REPAIRERS, BUILDINGS & MOBILE HOMES	16,230	102,060,580	0.02	98.16
518	91102	SAW MACHINE TOOLSETTERS	16,230	102,076,810	0.02	98.17
519	34058	ATHLETES, COACHES, UMPIRES & RELATED	16,180	102,092,990	0.02	98.19
520	85944	GAS APPLIANCE REPAIRERS	16,100	102,109,090	0.02	98.20
521	32113	CHIROPRACTORS	16,080	102,125,170	0.02	98.22
522	31204	CHEMISTRY TEACHERS	16,050	102,141,220	0.02	98.24
523	89199	OTHER PRECISION METAL WORKERS	15,990	102,157,210	0.02	98.25
524	32926	ELECTROCARDIOGRAPH TECHNICIANS	15,870	102,173,080	0.02	98.27
525	92917	COOKING MACHINE OPERATORS, FOOD & TOBACCO	15,780	102,188,860	0.02	98.28
526	85326	AIRCRAFT ENGINE SPECIALISTS	15,710	102,204,570	0.02	98.30
527	68002	BARBERS	15,490	102,220,060	0.01	98.31
528	79036	SPRAYERS/APPLICATORS	15,490	102,235,550	0.01	98.33
529	92723	SHOE SEWING MACHINE OPERATORS	15,460	102,251,010	0.01	98.34
530	68017	GUIDES	15,280	102,266,290	0.01	98.36
531	91917	ELECTROLYTIC PLATING & COATING MACHINE SETTERS	15,270	102,281,560	0.01	98.37
532	92938	CHEMICAL EQUIPMENT TENDERS	15,110	102,296,670	0.01	98.38
533	87314	REINFORCING METAL WORKERS	15,010	102,311,680	0.01	98.40
534	15032	LAWN SERVICE MGR	14,970	102,326,650	0.01	98.41
535	66021	OCCUPATIONAL THERAPY ASSISTANTS & AIDES	14,940	102,341,590	0.01	98.43
536	32399	ALL OTHER THERAPISTS	14,900	102,356,490	0.01	98.44
537	85932	ELEVATOR INSTALLERS/REPAIRERS	14,640	102,371,130	0.01	98.46
538	93923	SEWERS, HAND	14,480	102,385,610	0.01	98.47
539	83008	TRANSPORTATION INSPECTORS	14,400	102,400,010	0.01	98.48
540	92932	DAIRY PROCESSING EQUIPMENT OPERATORS, INCLUDING SETTERS	14,380	102,414,390	0.01	98.50
541	91314	ROLLING MACHINE SETTERS, OPERATORS, METAL/PLASTIC	14,320	102,428,710	0.01	98.51
542	92911	TIRE BUILDING MACHINE OPERATORS	14,240	102,442,950	0.01	98.53
543	95014	PETROLEUM REFINERY & CONTROL PANEL OPERATORS	14,210	102,457,160	0.01	98.54
544	53802	TRAVEL CLERKS	14,200	102,471,360	0.01	98.55
545	97902	LONGSHORE EQUIPMENT OPERATORS	14,180	102,485,540	0.01	98.57
546	89713	CAMERA OPERATORS	14,130	102,499,670	0.01	98.58
547	32925	CARDIOLOGY TECHNOLOGISTS	13,990	102,513,660	0.01	98.59
548	85956	MENDERS, GARMENTS, LINENS & RELATED	13,970	102,527,630	0.01	98.61
549	91317	FORGING MACHINE SETTERS, OPERATORS, METAL/PLASTIC	13,970	102,541,600	0.01	98.62
550	95028	POWER DISTRIBUTORS & DISPATCHERS	13,970	102,555,570	0.01	98.63

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
551	66023	AMBULANCE DRIVERS & ATTENDANTS	13,960	102,569,530	0.01	98.65
552	31209	OTHER PHYSICAL SCIENCES TEACHERS	13,940	102,583,470	0.01	98.66
553	73002	FALLERS & BUCKERS	13,890	102,597,360	0.01	98.67
554	25313	ACTUARIES	13,840	102,611,200	0.01	98.69
555	87105	CEILING TILE INSTALLERS & ACOUSTICAL CARPENTERS	13,820	102,625,020	0.01	98.70
556	89705	JOB PRINTERS	13,820	102,638,840	0.01	98.71
557	53108	TRANSIT CLERKS	13,790	102,652,630	0.01	98.73
558	31323	FARM/HOME MANAGEMENT ADVISORS	13,710	102,666,340	0.01	98.74
559	93944	MOLDERS & CASTERS, HAND	13,670	102,680,010	0.01	98.75
560	34026	CAMERA OPERATORS, TELEVISION & MOTION PICTURE	13,640	102,693,650	0.01	98.77
561	93108	FITTERS, STRUCTURAL METAL	13,560	102,707,210	0.01	98.78
562	85721	POWERHOUSE, SUBSTATION & RELAY ELECTRICIANS	13,480	102,720,690	0.01	98.79
563	92515	LETTERPRESS SETTERS	13,140	102,733,830	0.01	98.81
564	87308	TILE SETTERS, HARD	13,130	102,746,960	0.01	98.82
565	89117	PRECISION LAYOUT WORKERS	13,120	102,760,080	0.01	98.83
566	89718	PLATEMAKERS	13,060	102,773,140	0.01	98.84
567	85911	ELECTRIC METER INSTALLERS & REPAIRERS	12,990	102,786,130	0.01	98.86
568	79002	FOREST/CONSERVATION WORKERS	12,770	102,798,900	0.01	98.87
569	89902	PRECISION FOUNDRY MOLD & CORE MAKERS	12,760	102,811,660	0.01	98.88
570	24302	FORESTERS & CONSERVATION SCIENTISTS	12,750	102,824,410	0.01	98.89
571	31206	PHYSICS TEACHERS	12,600	102,837,010	0.01	98.90
572	32914	NUCLEAR MEDICINE TECHNOLOGISTS	12,560	102,849,570	0.01	98.92
573	31111	LECTURERS	12,560	102,862,130	0.01	98.93
574	73008	LOG HANDLING EQUIPMENT OPERATORS	12,500	102,874,630	0.01	98.94
575	92711	TEXTILE DRAW-OUT MACHINE OPERATORS	12,470	102,887,100	0.01	98.95
576	28311	TITLE EXAMINERS & ABSTRACTORS	12,380	102,899,480	0.01	98.96
577	22111	PETROLEUM ENGINEERS	12,320	102,911,800	0.01	98.98
578	85599	OTHER COMMUNICATION EQUIPMENT MECHANICS/INSTALL/REPAIR	12,270	102,924,070	0.01	98.99
579	68011	SHAMPOOERS	12,220	102,936,290	0.01	99.00
580	87902	EARTH DRILLERS, EXCEPT OIL & GAS	12,170	102,948,460	0.01	99.01
581	53111	LOAN INTERVIEWERS	12,100	102,960,560	0.01	99.02
582	98323	HELPERS, EXTRACTIVE WORKERS	12,070	102,972,630	0.01	99.03
583	92510	PRINTING PRESS MACHINE SETTERS	11,920	102,984,550	0.01	99.05
584	85113	MACHINERY MAINTENANCE MECHANICS, SEWING MACHINES	11,900	102,996,450	0.01	99.06
585	97517	ORDINARY SEAMEN & MARINE OILERS	11,870	103,008,320	0.01	99.07
586	21502	CLAIMS TAKERS, UNEMPLOYMENT BENEFITS	11,850	103,020,170	0.01	99.08
587	92522	SPECIALTY PRINTING MACHINE SETTERS	11,850	103,032,020	0.01	99.09
588	97502	CAPTAINS, WATER VESSEL	11,640	103,043,660	0.01	99.10
589	92921	ROASTING/BAKING/DRYING MACHINE OPERATORS	11,590	103,055,250	0.01	99.11
590	87305	STONEMASONS	11,380	103,066,630	0.01	99.13
591	63023	BAILIFFS	11,240	103,077,870	0.01	99.14
592	15021	MINING/QUARRYING/OIL-GAS WELL DRILLING MANAGERS	11,200	103,089,070	0.01	99.15
593	89514	SPOTTERS, DRY CLEANING	10,820	103,099,890	0.01	99.16
594	93928	PORTABLE MACHINE CUTTERS	10,800	103,110,690	0.01	99.17
595	53505	INVESTIGATORS, CLERICAL	10,700	103,121,390	0.01	99.18
596	25312	STATISTICIANS	10,700	103,132,090	0.01	99.19
597	92302	SAWING MACHINE SETTERS	10,630	103,142,720	0.01	99.20
598	89917	PRECISION OPTICAL GOODS WORKERS	10,530	103,153,250	0.01	99.21
599	89899	OTHER PRECISION FOOD & TOBACCO WORKERS	10,510	103,163,760	0.01	99.22
600	89399	OTHER PRECISION WOODWORKERS	10,430	103,174,190	0.01	99.23
601	85505	FRAME WIRERS, CENTRAL OFFICE	10,410	103,184,600	0.01	99.24
602	89121	SHIPFITTERS	10,400	103,195,000	0.01	99.25
603	89905	PRECISION MOLDERS, SHAPERS, CASTERS & CARVERS	10,360	103,205,360	0.01	99.26
604	22308	LANDSCAPE ARCHITECTS	10,250	103,215,610	0.01	99.27
605	34053	DANCERS & CHOREOGRAPHERS	10,100	103,225,710	0.01	99.28

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
606	93941	METAL POURERS & CASTERS, BASIC SHAPES	9,710	103,235,420	0.01	99.29
607	92529	OTHER PRINTING & RELATED SETTERS	9,700	103,245,120	0.01	99.30
608	97514	ABLE SEAMEN	9,600	103,254,720	0.01	99.31
609	89302	PATTERN & MODEL MAKERS	9,540	103,264,260	0.01	99.32
610	31508	AUDIO-VISUAL SPECIALISTS	9,500	103,273,760	0.01	99.32
611	28308	TITLE SEARCHERS	9,460	103,283,220	0.01	99.33
612	97308	RAIL YARD ENGINEERS, DINKEY OPERATORS & HOSTLERS	9,170	103,292,390	0.01	99.34
613	85951	BICYCLE REPAIRERS	9,150	103,301,540	0.01	99.35
614	87511	SEPTIC TANK SERVICERS & SEWER PIPE CLEANERS	9,110	103,310,650	0.01	99.36
615	97911	WELL HEAD PUMPERS	9,030	103,319,680	0.01	99.37
616	27502	CLERGY	8,990	103,328,670	0.01	99.38
617	24102	PHYSICISTS & ASTRONOMERS	8,980	103,337,650	0.01	99.39
618	91914	FOUNDRY MOLD ASSEMBLY & SHAKEOUT WORKERS	8,950	103,346,600	0.01	99.39
619	95005	GAS PLANT OPERATORS	8,920	103,355,520	0.01	99.40
620	87605	FLOOR LAYERS, EXCEPT CARPET, WOOD & HARD TILES	8,860	103,364,380	0.01	99.41
621	85908	ELECTROMEDICAL & BIOMEDICAL EQUIPMENT REPAIRERS	8,860	103,373,240	0.01	99.42
622	22117	NUCLEAR ENGINEERS	8,830	103,382,070	0.01	99.43
623	89599	OTHER PRECISION TEXTILE, APPAREL & FURNISHINGS WORKERS	8,830	103,390,900	0.01	99.44
624	87914	DERRICK OPERATORS, OIL & GAS EXTRACTION	8,550	103,399,450	0.01	99.45
625	85935	RIGGERS	8,480	103,407,930	0.01	99.45
626	85923	LOCKSMITHS & SAFE REPAIRERS	8,450	103,416,380	0.01	99.46
627	85308	MOTORCYCLE REPAIRERS	8,210	103,424,590	0.01	99.47
628	89914	PRECISION PHOTOGRAPHIC PROCESS WORKERS	8,160	103,432,750	0.01	99.48
629	92905	MOTION PICTURE PROJECTIONISTS	8,130	103,440,880	0.01	99.49
630	87911	ROTARY DRILL OPERATORS, OIL & GAS EXTRACTION	8,110	103,448,990	0.01	99.49
631	87114	LATHERS	8,040	103,457,030	0.01	99.50
632	63041	FISH & GAME WARDENS	7,960	103,464,990	0.01	99.51
633	95023	AUXILIARY EQUIPMENT OPERATORS, POWER	7,780	103,472,770	0.01	99.52
634	63002	FIRE INSPECTORS	7,710	103,480,480	0.01	99.52
635	25310	MATHEMATICAL SCIENTISTS	7,650	103,488,130	0.01	99.53
636	39008	RADIO OPERATORS	7,550	103,495,680	0.01	99.54
637	27505	DIRECTORS, RELIGIOUS ACTIVITIES & EDUCATION	7,470	103,503,150	0.01	99.55
638	89126	PRECISION HAND WORKERS, JEWELRY & RELATED PRODUCTS	7,460	103,510,610	0.01	99.55
639	97521	SHIP ENGINEERS	7,390	103,518,000	0.01	99.56
640	92519	OTHER PRINTING PRESS SETTERS	7,350	103,525,350	0.01	99.57
641	97941	HOIST & WINCH OPERATORS	7,340	103,532,690	0.01	99.57
642	34047	MUSIC DIRECTORS, SINGERS, COMPOSERS & RELATED	7,290	103,539,980	0.01	99.58
643	63021	PARKING ENFORCEMENT OFFICERS	7,250	103,547,230	0.01	99.59
644	34014	BROADCAST NEWS ANALYSTS	7,240	103,554,470	0.01	99.59
645	89702	HAND COMPOSITORS & TYPESETTERS	7,220	103,561,690	0.01	99.60
646	53305	INSURANCE APPRAISERS, AUTO DAMAGE	7,210	103,568,900	0.01	99.61
647	97505	MATES, SHIP/BOAT/BARGE	7,130	103,576,030	0.01	99.62
648	85514	RADIO MECHANICS	7,100	103,583,130	0.01	99.62
649	39014	EMBALMERS	7,030	103,590,160	0.01	99.63
650	68099	OTHER PERSONAL SERVICE	7,020	103,597,180	0.01	99.64
651	25111	PROGRAMMERS-NUMERICAL, TOOL & PROCESS CONTROL	7,020	103,604,200	0.01	99.64
652	53308	INSURANCE EXAMINING CLERKS	6,970	103,611,170	0.01	99.65
653	97953	PUMP OPERATORS	6,720	103,617,890	0.01	99.66
654	92928	COOLING & FREEZING EQUIPMENT OPERATORS	6,660	103,624,550	0.01	99.66
655	25319	OTHER MATHEMATICAL SCIENTISTS	6,590	103,631,140	0.01	99.67
656	87702	AIR HAMMER OPERATORS	6,590	103,637,730	0.01	99.67
657	95017	GAUGERS	6,500	103,644,230	0.01	99.68
658	85117	UNDERGROUND MINE MACHINERY MECHANICS	6,370	103,650,600	0.01	99.69
659	32923	ELECTROENCEPHALOGRAPH TECHNOLOGISTS	6,350	103,656,950	0.01	99.69
660	34052	FILM EDITORS	6,330	103,663,280	0.01	99.70

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
661	24511	PETROLEUM TECHNICIANS & TECHNOLOGISTS	6,290	103,669,570	0.01	99.71
662	89712	PHOTOENGRAVERS	6,260	103,675,830	0.01	99.71
663	32111	PODIATRISTS	6,170	103,682,000	0.01	99.72
664	92799	OTHER TEXTILE & RELATEDSETTERS & OPERATORS	6,030	103,688,030	0.01	99.72
665	91928	HEATING EQUIPMENT SETTERS, OPERATORS, METAL/PLASTIC	5,860	103,693,890	0.01	99.73
666	89721	BOOKBINDERS	5,560	103,699,450	0.01	99.73
667	57111	TELEGRAPH/TELETYPE OPERATORS	5,490	103,704,940	0.01	99.74
668	89715	SCANNER OPERATORS	5,490	103,710,430	0.01	99.74
669	91711	SOLDERING/BRAZING MACHINE OPERATORS	5,460	103,715,890	0.01	99.75
670	68032	WARDROBE, LOCKER & DRESSING ROOM ATTENDANTS	5,450	103,721,340	0.01	99.76
671	22517	ESTIMATORS & DRAFTERS, UTILITIES	5,430	103,726,770	0.01	99.76
672	87949	OTHER MINING MACHINE OPERATORS	5,270	103,732,040	0.01	99.77
673	92305	HEAD SAWYERS	5,230	103,737,270	0.01	99.77
674	31511	CURATORS/ARCHIVISTS/MUSEUM TECHNICIANS & RESTORERS	5,120	103,742,390	0.00	99.78
675	24305	AGRICULTURAL & FOOD SCIENTISTS	5,020	103,747,410	0.00	99.78
676	67011	ELEVATOR OPERATORS	5,000	103,752,410	0.00	99.78
677	85914	CAMERA & PHOTOGRAPHIC EQUIPMENT REPAIRERS	4,930	103,757,340	0.00	99.79
678	87941	CONTINUOUS MINING MACHINE OPERATORS	4,800	103,762,140	0.00	99.79
679	87688	FLOOR SANDING MACHINE OPERATORS	4,680	103,766,820	0.00	99.80
680	32199	OTHER HEALTH DIAGNOSING & TREATING PRACTITIONERS	4,630	103,771,450	0.00	99.80
681	97985	TANK CAR & TRUCK LOADERS	4,620	103,776,070	0.00	99.81
682	87923	ROOF BOLTERS	4,520	103,780,590	0.00	99.81
683	92545	PHOTOENGRAVING/LITHOGRAPHING MACHINE OPERATORS	4,460	103,785,050	0.00	99.82
684	39005	TRAFFIC TECHNICIANS	4,450	103,789,500	0.00	99.82
685	93911	GLAZIERS, MANUFACTURING	4,450	103,793,950	0.00	99.82
686	85399	OTHER MOBILE EQUIPMENT MECHANICS/INSTALL/REPAIR	4,300	103,798,250	0.00	99.83
687	68028	TRANSPORTATION ATTENDANTS, EXCEPT FLIGHT & PORTERS	3,980	103,802,230	0.00	99.83
688	57199	OTHER COMMUNICATIONS OPERATORS	3,970	103,806,200	0.00	99.84
689	89799	OTHER PRECISION PRINTING WORKERS	3,970	103,810,170	0.00	99.84
690	85921	MUSICAL INSTRUMENT REPAIRERS & TUNERS	3,920	103,814,090	0.00	99.84
691	89521	PRECISION DYERS	3,900	103,817,990	0.00	99.85
692	93951	ENGRAVING & PRINTING WORKERS, HAND	3,850	103,821,840	0.00	99.85
693	95026	POWER REACTOR OPERATORS	3,780	103,825,620	0.00	99.86
694	73005	CHOKE SETTERS	3,730	103,829,350	0.00	99.86
695	91708	SOLDERING/BRAZING MACHINE SETTERS	3,670	103,833,020	0.00	99.86
696	63005	FOREST FIRE INSPECTORS & PREVENTION SPECIALISTS	3,620	103,836,640	0.00	99.87
697	97908	OIL PUMPERS, EXCEPT WELL HEAD	3,600	103,840,240	0.00	99.87
698	97935	SHUTTLE CAR OPERATORS	3,560	103,843,800	0.00	99.87
699	91923	NONELECTROLYTIC PLATING & COATING MACHINE SETTERS	3,550	103,847,350	0.00	99.88
700	89911	PRECISION DETAIL DESIGN DECORATORS & PAINTERS	3,530	103,850,880	0.00	99.88
701	24508	NUCLEAR TECHNICIANS & TECHNOLOGISTS	3,420	103,854,300	0.00	99.88
702	85917	WATCHMAKERS	3,420	103,857,720	0.00	99.89
703	87985	BLASTERS & EXPLOSIVES WORKERS	3,410	103,861,130	0.00	99.89
704	79021	FARM EQUIPMENT OPERATORS	3,390	103,864,520	0.00	99.89
705	79008	LOG GRADERS & SCALERS	3,380	103,867,900	0.00	99.90
706	22138	MARINE ENGINEERS	3,340	103,871,240	0.00	99.90
707	63058	RAILROAD & TRANSIT POLICE & SPECIAL AGENTS	3,280	103,874,520	0.00	99.90
708	91938	HEATERS, METAL/PLASTIC	3,200	103,877,720	0.00	99.91
709	97926	DRAGLINE OPERATORS	3,140	103,880,860	0.00	99.91
710	89105	PRECISION INSTRUMENT MAKERS	3,130	103,883,990	0.00	99.91
711	89114	PATTERN & MODEL MAKERS	3,010	103,887,000	0.00	99.91
712	91926	NONELECTROLYTIC PLATING & COATING MACHINE OPERATORS	3,000	103,890,000	0.00	99.92
713	15031	NURSERY & GREENHOUSE MGR	2,970	103,892,970	0.00	99.92
714	89923	MEDICAL APPLIANCE MAKERS	2,940	103,895,910	0.00	99.92
715	85511	SIGNAL OR TRACK SWITCH MAINTAINERS	2,920	103,898,830	0.00	99.93

Frame in Descending order of TOT_EMPL

OBS	OCCUCODE	OCC_TITL	TOT_EMPL	CUM_TOT	PCT	CUM_PCT
716	85116	MACHINERY MAINTENANCE MECHANICS, MARINE EQUIPMENT	2,800	103,901,710	0.00	99.93
717	97921	GAS COMPRESSOR OPERATORS	2,800	103,904,510	0.00	99.93
718	95011	PETROLEUM PUMP SYSTEM OPERATORS	2,790	103,907,300	0.00	99.93
719	89719	OTHER LITHOGRAPHY & PHOTOENGRAVING WORKERS	2,780	103,910,080	0.00	99.94
720	87505	PIPELAYING FITTERS	2,620	103,912,700	0.00	99.94
721	97932	LOADING MACHINE OPERATORS, UNDERGROUND MINING	2,620	103,915,320	0.00	99.94
722	97802	BRIDGE, LOCK & LIGHTHOUSE TENDERS	2,480	103,917,800	0.00	99.94
723	97399	OTHER RAIL VEHICLE OPERATORS & CONTROLLERS	2,480	103,920,280	0.00	99.95
724	24108	ATMOSPHERIC & SPACE SCIENTISTS	2,470	103,922,750	0.00	99.95
725	73099	OTHER TIMBER CUTTING & RELATED LOGGING WORKERS	2,270	103,925,020	0.00	99.95
726	89128	PRECISION ETCHERS/ENGRAVERS, HAND OR MACHINE	2,180	103,927,200	0.00	99.95
727	79015	ANIMAL BREEDERS	2,140	103,929,340	0.00	99.96
728	93117	WATCH/CLOCK/CHRONOMETER ASSEMBLE/ADJUST/CALIBRATE	2,140	103,931,480	0.00	99.96
729	22108	MINING ENGINEERS, INCLUDING MINE SAFETY	2,130	103,933,610	0.00	99.96
730	39002	AIRPLANE DISPATCHERS & AIR TRAFFIC CONTROLLERS	2,130	103,935,740	0.00	99.96
731	97928	DREDGE OPERATORS & DIPPER TENDERS	2,110	103,937,850	0.00	99.96
732	85126	REFRACTORY MATERIALS REPAIR, EXCEPT BRICK MASONS	2,080	103,939,930	0.00	99.97
733	97508	PILOTS, SHIP	2,050	103,941,980	0.00	99.97
734	87943	MINE CUTTING & CHANNELING MACHINE OPERATORS	2,000	103,943,980	0.00	99.97
735	53199	OTHER BANKING, SECURITY, FINANCE & CREDIT WORKERS	1,960	103,945,940	0.00	99.97
736	22123	AGRICULTURAL ENGINEERS	1,880	103,947,820	0.00	99.97
737	89908	PRECISION PATTERNMAKERS, MODEL MAKERS & LAYOUT WORKERS	1,750	103,949,570	0.00	99.97
738	32311	CORRECTIVE & MANUAL ARTS THERAPISTS	1,700	103,951,270	0.00	99.98
739	79016	ANIMAL TRAINERS	1,650	103,952,920	0.00	99.98
740	97914	MAIN LINE STATION ENGINEERS	1,420	103,954,340	0.00	99.98
741	87705	PILE DRIVING OPERATORS	1,400	103,955,740	0.00	99.98
742	93932	CARPET CUTTERS, DIAGRAMMERS & SEAMERS	1,360	103,957,100	0.00	99.98
743	34021	ANNOUNCERS, EXCEPT RADIO & TELEVISION	1,270	103,958,370	0.00	99.98
744	89926	GEM & DIAMOND WORKERS	1,270	103,959,640	0.00	99.98
745	87199	OTHER CARPENTRY & RELATED	1,190	103,960,830	0.00	99.99
746	87908	ROCK SPLITTERS, QUARRY	1,190	103,962,020	0.00	99.99
747	97311	LOCOMOTIVE FIRERS	1,190	103,963,210	0.00	99.99
748	87599	OTHER PLUMBING & RELATED	1,180	103,964,390	0.00	99.99
749	13099	OTHER ADMINISTRATIVE MANAGERS	1,130	103,965,520	0.00	99.99
750	89305	PATTERN MAKERS, WOOD	1,030	103,966,550	0.00	99.99
751	25399	OTHER SYSTEMS RESEARCHERS	930	103,967,480	0.00	99.99
752	87121	BRATTICE BUILDERS	780	103,968,260	0.00	99.99
753	97511	MOTORBOAT OPERATORS	670	103,968,930	0.00	99.99
754	25323	MATHEMATICAL TECHNICIANS	650	103,969,580	0.00	99.99
755	98399	OTHER CONSTRUCTION TRADES/EXTRACTIVE WORKER HELPERS	630	103,970,210	0.00	99.99
756	85508	TELEGRAPH & TELETYPE INSTALLERS & MAINTAINERS	610	103,970,820	0.00	99.99
757	97917	GAS PUMPING STATION OPERATORS	610	103,971,430	0.00	100.00
758	31599	OTHER LIBRARIANS/ARCHIVISTS & CURATORS	590	103,972,020	0.00	100.00
759	87399	OTHER MASONRY & RELATED	560	103,972,580	0.00	100.00
760	27399	OTHER SOCIAL SCIENCE & RELATED	530	103,973,110	0.00	100.00
761	87499	OTHER PAINTING & REL WKRS	430	103,973,540	0.00	100.00
762	87799	OTHER ROAD, RAIL & RELATED CONSTRUCTION & MAINTENANCE	420	103,973,960	0.00	100.00
763	22399	OTHER ARCHITECTS, SURVEYING & MAPPING SCIENTISTS	400	103,974,360	0.00	100.00
764	15099	OTHER SERVICES MANAGERS	350	103,974,710	0.00	100.00
765	87699	OTHER FLOOR RELATED, EXCEPT CARPENTERS	270	103,974,980	0.00	100.00
766	22305	MARINE ARCHITECTS	250	103,975,230	0.00	100.00
767	57399	OTHER MAIL & MESSAGE DISTRIBUTORS	230	103,975,460	0.00	100.00
768	53399	OTHER INSURANCE EXAMINERS, APPRAISERS & CLERKS	210	103,975,670	0.00	100.00
769	98799	OTHER FREIGHT, STOCK & MATERIAL MOVERS, HAND	210	103,975,880	0.00	100.00
770	28199	OTHER LAWYERS & RELATED	130	103,976,010	0.00	100.00

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Frame in Descending order of TOT_EMPL

OBS    OCCUCODE              OCC_TITL                       TOT_EMPL        CUM_TOT     PCT   CUM_PCT

771     97599     OTHER WATER TRANSPORTATION WORKERS               10    103,976,020    0.00    100.00
                                                        =============                 ======
                                                          103,976,020                 100.00
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Seminar Attendees

Nickie Askov

Louise Bertsch

Al Borrego

David Cantor

Peter Cappelli

Richard Castor

Fred Conrad

Sal Corrallo

Lynn Cossette

Monica Dashen

Donald Drewes

Donna Dye

Arline Easley

Daniel Flaming

John Fowlkes

Pam Frugoli

Vicky Galifaro

Arnold Gerber

Marilyn Gowing

Donna Gregory

Paul Hadlock

Linda Hardy

Jim Hubbard

Sherril Hurd

Sherri Jurkofsky

Barbara Kaufmann

Tom Kearney

Karen Kelly

Mary Kosko

Jackie Kraemer

Nina Lalich

Anita Lancaster

Juliette Lester

Kerry Levin

Jules Lichtenstein

Robert Litman

Audrey Little

Brian MacDonald

Ronald McCage

Michaela Meehan

Michael McElroy

Alan Moss

Charles Nelson

Ruth O'Donnell

Bruce Paige

Emily Rick Parry

Kenneth Pearlman

Norm Peterson

Michael Pilot

Thomas Plewes

Thomas Powell

John Priebe

Kay Raithel

Bruce Rankin

Marc Rosenblum

Neal Rosenthal

Laura Ross

Marilyn Silver

Barbara Smith

Rod Smith

Edward Spar

David Stevens

Glenda Stewart

William Strickland

Carolyn Summers

James Vollman

Joseph Waksberg

Clint Walker

Katherine Wallman

Kathy Walsh

Daniel Weinberg

James Woods

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